US Army Corps
of Engineers
St. Paul District

DESIGN MEMORANDUM NO. 3
FLOOD CONTROL PROJECT
AND DRAFT ENVIRONMENTAL ASSESSMENT

East Creek
Stage 3
Chaska, Minnesota

DECEMBER 1993

REPORT DOCUMENTATION PAGE	*Form Approved OMB No. 0704-0188*

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East Creek stage 3 Chaska, Minnesota: design memorandum no. 3, flood control project and draft environmental assessment.

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5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

6. AUTHOR(S)

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U.S. Army Corps of Engineers, St. Paul
190 5th St. E.
St. Paul, MN 55101

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12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release, distribution

13. SUPPLEMENTARY NOTES

14. ABSTRACT
This design memorandum presents the design and discussion of planning for stage 3 which consists of a diversion channel that protects Chaska from flooding of East Creek. Works includes trapezoidal riprap channel, articulated concrete channel, drop structures, outlets with gatewells, roadway bridges, landscaping, recreation trail and the remaining stage 4 levee at the East Creek intersection.

15. SUBJECT TERMS
Flood control
Minnesota River

16. SECURITY CLASSIFICATION OF: a. REPORT	b. ABSTRACT	c. THIS PAGE	17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON / 19b. TELEPHONE NUMBER *(Include area code)*
Unclassified	Unclassified	Unclassified			

ACCOUNT CODE	ITEM	UNIT	QUANTITY	UNIT PRICE	AMOUNT	CONTINGENCIES AMOUNT	PERCENT	REASON
01.-.-.-	LANDS AND DAMAGES							
01.B.-.-	PROJECT PLANNING	LS	0	$0	$0	$0	0.00	1
01.B.-.-	ACQUISITION:							
01.B.1.-	BY GOVT,DIRECT FEDERAL	OSP			0	0	0.0	1
01.B.2.-	BY LOCAL SPONSOR	OSP	38	600	22,800	2,300	0.0	1
01.B.3	BY GOVT. ON BEHALF OF LS	OSP			0	0	0.0	1
01.B.4	GOVT. REVIEW OF LS ACTIVITIES	OSP	38	345	13,100	1,900	0.0	1
01.C.-.-	CONDEMNATIONS							
01.C.1.-	BY GOVT.	TRT	0	0	0	0	0.0	1
01.C.2.-	BY LOCAL SPONSOR	TRT	4	1,000	4,000	400	10.0	2,3 &4
01.C.3.-	BY GOVT. ON BEHALF OF LS	TRT	0	0	0	0	0.0	1
01.C.2.-	GOVT. REVIEW OF LS ACTIVITIES	TRT	4	200	800	100	12.5	2,3 &4
01.E.-.-	APPRAISALS:							
01.E.1.	BY GOVT. (IN HOUSE)	OSP	0	0	0	0	0.0	1
01.E.2.	BY GOVT. (CONTRACT)	OSP	0	0	0	0	0.0	1
01.E.3.	BY LOCAL SPONSOR	OSP	38	500	19,000	1,900	10.0	2,3 &4
01.E.4.	BY GOVT. ON BEHALF OF LS	OSP	0	0	0	0	0.0	1
01.E.5.	GOVT. REVIEW OF LS ACTIVITIES	OSP	38	250	9,500	1,400	14.7	2,3 &4
01.F.-.-	PL 91-646 ASSISTANCE							
01.F.1.-	P.L.91-646 RELOCATIONS - LOCAL SPONSOR	OSP	11	300	3,300	300	9.1	2,3 &4
01.F.2.	FEDERAL REVIEW OF DOCUMENTS	OSP	0	0	0	0	0.0	1
01.F.3.	BY GOVT. ON BEHALF OF LS	OSP	0	0	0	0	0.0	1
01.F.4.	GOVT. REVIEW OF LS ACTIVITIES	OSP	11	200	2,200	300	13.6	2,3 &4
01.G.-.-	TEMPORARY PERMITS	OSP	0	0	0	0	0.0	1
01.G.1.-	BY GOVT.	OSP	0	0	0	0	0.0	1
01.G.2.	BY LOCAL SPONSOR	OSP	0	0	0	0	0.0	1
01.G.3.	BY GOVT. ON BEHALF OF LS	OSP	0	0	0	0	0.0	1
01.G.4.	GOVT. REVIEW OF LS ACTIVITIES	OSP	0	0	0	0	0.0	1
01.G.5.	OTHER	OSP	0	0	0	0	0.0	1
01.G.6.	DAMAGE CLAIMS	OSP	0	0	0	0	0.0	1

ACCOUNT CODE	ITEM	UNIT	QUANTITY	UNIT PRICE	AMOUNT	CONTINGENCIES AMOUNT	PERCENT	REASON
01.R.-.-	REAL ESTATE RECEIPTS/PAYMENTS:							
01.R.1.-	LAND PAYMENTS							
01.R.1.A	BY GOVT.	LS	1	0	0	0	0.0	1
01.R.1.B	BY LOCAL SPONSOR	LS			735,567	110,000	15.0	2,3 &4
01.R.1.C	BY GOVT. ON BEHALF OF LS	LS	1	0	0	0	0.0	1
01.R.1.D	GOVT. REVIEW OF LS ACTIVITIES	LS	1	0	0	0	0.0	1
01.R.2.-	PL 91-646 ASSISTANCE PAYMENTS		1	0				
01.R.2.A	BY GOVT.	LS	1	0	0	0	0.0	1
01.R.2.B	BY LOCAL SPONSOR	LS	11	42,850	471,400	0	0.0	1
01.R.2.C	BY GOVT. ON BEHALF OF LS	LS	1	0	0	0	0.0	1
01.R.2.D	GOVT. REVIEW OF LS ACTIVITIES	LS	1	0	0	0	0.0	1
01.R.3.-	DAMAGE PAYMENTS							
01.R.3.A	BY GOVT.	LS	1	0	0	0	0.0	1
01.R.3.B	BY LOCAL SPONSOR	LS			222,400	34,000	15.3	2,3 &4
01.R.3.C	BY GOVT. ON BEHALF OF LS	LS	1	0	0	0	0.0	1
01.R.3.D	GOVT. REVIEW OF LS ACTIVITIES	LS	1	0	0	0	0.0	1
01.R.9.-	OTHER	LS	1	0	0	0	0.0	1
01.T.-.-	LERRD CREDITS							
01.T.1.	LAND PAYMENTS	LS	1	0	0	0	0.0	1
01.T.2.	ADMINISTRATIVE COSTS	LS	1	0	0	0	0.0	1
01.T.3.	PL 91-646 ASSISTANCE	LS	1	0	0	0	0.0	1
01.T.4.	ALL OTHER	LS	1	0	0	0	0.0	1
	SUBTOTAL REAL ESTATE COSTS				$1,504,000			
	SUBTOTAL CONTINGENCIES (AVER.)		10.2%			$153,000		
	TOTAL 01. LANDS AND DAMAGES					$1,657,000		

REASONS FOR CONTINGENCIES:
1. NOT APPLICABLE.
2. UNKNOWNS DUE TO LEGAL COST.
3. UNKNOWNS DUE TO LAND PRICES.
4. UNKNOWNS DUE TO QUANTITIES.

NOTES:
A. FEDERAL, NONFEDERAL COST TO BE IN ACCORDANCE WITH 1986 WRDA.
B. UNIT PRICES ARE AT APRIL 1991 PRICE LEVEL.
C. TRT = TRACT
D. OSP = OWNERSHIP
E. LS = LUMPSUM

DEC 23 1993

DEPARTMENT OF THE ARMY

ST. PAUL DISTRICT, CORPS OF ENGINEERS
190 FIFTH STREET EAST
ST. PAUL, MINNESOTA 55101-1638

REPLY TO
ATTENTION OF

13 December 1993

CENCS-ED-M (1110)

MEMORANDUM FOR: Commander, North Central Division, ATTN: CENCD-PE-ED, 111 North Canal Street, Chicago, Illinois 60606-7205

SUBJECT: Flood Control at Chaska, Minnesota, Design Memorandum No. 3, Stage 3, East Creek

1. Subject report is submitted in accordance with ER 1110-2-1150 for your review and approval.

2. This design memorandum presents the design improvements for construction of the East Creek Diversion Channel, levee at East Creek, and related structures as well as recreational features for the flood control project at Chaska, Minnesota.

FOR THE COMMANDER:

Encl (16 cys)
Chaska Stage 3 DM
Sent under separate cover

Stan Kempel
for ROBERT F. POST, P.E.
Chief, Engineering Division

CENCD-PE-ED-TM (CENCS-ED-M/23 Dec 93) (1110-2-1150a) 1st End
Mr. Ordonez/mgb/(312) 353-9057
SUBJECT: Flood Control at Chaska, Minnesota, Design Memorandum No. 3, Stage 3, East Creek

Commander, North Central Division, U.S. Army Corps of Engineers,
111 North Canal Street, Chicago, IL 60606-7205

31 JAN 1994

FOR Commander, St. Paul District, ATTN: CENCS-ED-M

1. DM No. 3 is approved subject to satisfactory resolution of the enclosed comments.

2. The HQ, NCD, POC is Mr. Jose Ordonez, CENCD-PE-ED-TM, (312) 353-9057.

FOR THE COMMANDER:

2 Encls
wd encl 1
Added 1 encl
2. as

JOHN P. D'ANIELLO, P.E.
Director, Engineering and
Planning Directorate

CENCS-PE-M (PE-M/23 Dec 93) (1110) 2nd End
Mr. Heyerman/vjf/(612) 290-5432
SUBJECT: Flood Control at Chaska, Minnesota, Design Memorandum No. 3, Stage 3, East Creek

Commander, U.S. Army Corps of Engineers, St. Paul District, 190 Fifth Street East, St. Paul, Minnesota 55101-1638 2 MAR 94
2 MAR 1994

FOR Commander, North Central Division, ATTN: CENCD-PE-ED-TM, River Center Building, 14th Floor, 111 North Canal Street, Chicago, Illinois 60606-7205

1. Responses to comments contained in the 1st endorsement follow with reference to commenter name and number.

2. Simpson 1a. and 1b. The uplift on the riverward slope is not a concern since it is resisted by the weight of the water on top of the riverward slope. Since the cutoff trench depth is limited to 6 feet or the height of the levee for levee heights less than 6 feet, it is unlikely that this would increase the groundwater levels behind the levee.

3. Simpson 2. Any existing pipes will be exposed during channel excavation. The embankments are considerably wider than the levees and excessive pressures under the landside top stratum at an embankment are less likely to be a concern. A large portion of the larger embankments will also have less than 2 feet of head on them.

4. Simpson 3. Adequate consolidation should occur within 300 days.

5. Simpson 4. The 4 inch drains were to assist in drainage during the time the road surcharge was in place, approximately one year. After this period of time the drains are not needed and there should be no consequences caused by blocking the drains.

6. Simpson 5. Samples taken from the Chaska Stage 4 borrow area were taken and compacted to 95% of maximum density with a water content slightly below optimum. This was not sufficient to completely saturate the test specimens and therefore a phi value higher than zero can be expected. Due to the short duration of the design flood, it is unlikely that the levees will become saturated.

7. Simpson 6. The relatively flat slope will be stable using either drained or undrained strengths. Analyses done using approximately half the actual undrained strength show an adequate factor of safety. It is unlikely that there will be steady state groundwater flows out of the slope as the borings indicate fairly thick impervious soils in the vicinity of the cut. Springs are much more likely where a thin impervious layer is underlain by pervious soils. Design water loads were not included in the analyses of the slope but the shallow flow depth expected (1.5' per Table B-1 on page B-3) will not generate a substantial load. Ice loads were not considered during the slope stability analyses but will be looked at for the design of the slope protection. As discussed in paragraph 61 on page D-18 rapid excavation of the lime is not recommended. Plate 3 shows that the existing material currently stands at steep slopes.

8. Simpson 7a. and 7b. In the majority of cases the expected settlement period will not be required for construction scheduling. The surcharge at drop structure 1 will be required only for a minimal amount of time (maybe a month) as it is primarily being used to preload the underlying pervious soils. Adequate consolidation at Outlet D should occur within 300 days of placing the surcharge during Stage 4 construction. Since it would be uneconomical to wait for complete consolidation before paving the trails the intent was to make the paving the last work item in the construction contract.

9. Simpson 8. The cutoffs are not deep and appear to be most economically constructed using concrete. Because of the question of percentage effectiveness, if sheetpile was used the cutoff lengths would need to be increased. Because of the small quantity and the locations a slurry wall cutoff would probably not be cost effective.

10. Occhipinti 9. The flood of 1993 is the only period since 1 October 1934 when pumping would have been required to eliminate interior flood damage in both the Outlet A and Pond D areas of Chaska. Based on a study of rainfall and streamflow records during this period, it appears the current design will allow the use of the same pump at both locations. Pumping in the Chaska Creek (Outlet A) area during the 1993 flood period, theoretically would have been required on 24 and 29 June, and 1 and 3 July. If the portable pump was temporarily moved to Pond D on 2 July, with about three hours of pumping from Pond D, the maximum pond D level would have been only about 712.7, or about 2.3 feet below the top of the dike separating Pond D and Courthouse Lake. Should no pump have been provided in the Pond D area, it is

estimated that about four acre feet of East Creek runoff would have discharged into Courthouse Lake between 11 July and 15 July when the Minnesota River would have receded below elevation 714.0 and the gravity outlet opened. Overflow from East Creek into Courthouse Lake could result in short term degradation of water quality in the lake, which could require restocking to restore or maintain the fishery levels in the lake.

11. Occhipinti 10. Table B-1 was moved and pages B-2 and B-3 revised accordingly.

12. Occhipinti 11. The revised page B-3 shows cfs being changed to cfs/ft.

13. Occhipinti 12. The average velocity was added to Table B-4 and a note was added to indicate that the average velocity is for the design discharge of 5500 cfs. The change is reflected in revised page B-6.

14. Occhipinti 13. The equation was corrected to: $y = (CV^2W)/(gr)$. The change is reflected in revised page B-9.

15. Occhipinti 14. Although the thickness could probably be reduced, the gradation would be unchanged. At this time it is felt that the 36 inches, although conservative, is recommended. The total length at this thickness is 70 feet.

16. Occhipinti 15. The bridge locations were added to Table B-22. The change is reflected in revised page B-17.

17. Occhipinti 16. A Courthouse Lake level of 703.0 is specifically indicated on the USGS quad sheet. Storage volumes and surface areas were obtained from another map with a contour interval of two feet. Based on a contour interval of two feet, the consequence would be an error of only about one foot. The second sentence of paragraph 12 has been changed to include the following: "...715.0 (obtained from a topographic map with a 2-foot contour interval) is...". The change is reflected in revised page C-3.

18. Occhipinti 17. The HEC-1 and HEC-2 models were changed, not the programs. In the second line of paragraph 33, the word "programs" has been changed to "models". The change is reflected in revised page C-21.

19. Ordonez 18. We believe the guidance provided in ER 1105-2-100, paragraph 5-18 was followed.

20. Ordonez 19. The main safety concern for this type of drop structure would be the rollers created. The Chaska project is a diversion channel which would be used only during periods of flooding and would normally be dry. A stepped drop structure as used on the Fruen Mill project would create safety concerns due to it's attractive climbing potential.

21. Dice 20. Concur; no requirement for ponding was shown on drawings provided for the Stage 3 initial cost estimate. Additional cost estimating data will be provided when the information required to complete a cost estimate on ponding is received.

22. Dice 21. The 3.9 acres in fee are included within the total 35.3 acres required for Stage 3. Fee acres are required due to their function as part of the recreation trail/bike path. A proper allocation of Public Use space was not made in the initial estimate. The Permanent Levee/Channel allocation of Public Use has been corrected to 2.36 acres. Page 9 has been revised.

23. Dice 22. Contingencies are estimated because of the methods employed to arrive at values, unknown acreages due to meander of the river, no known boundary lines or ownership information, type of improvements involved in the take area, amount of elapsed time before the project may become a reality and other unknown elements that are not considered in this estimate. Page 9 has been revised.

24. Dice 23. Concur; the estimated value of the residences has been reflected as a part of the total lands and damages estimate. See attached Revised Real Estate Cost Estimate, Enclosure 4. Page H-5 should be deleted and replaced with a revised page H-5 and page H-5a. Also page 9 and 10 revised accordingly.

25. Dice 24. The modular/mobile homes are considered real estate; the estimated lands and damages included the value of the improvements.

26. Dice 25. No disposal areas were shown in the DM because Stage 3 spoil will be placed upon land ownerships where fill is wanted; therefore, this action will be accomplished with no cost to the project or to the Local Sponsor.

CENCS-PE-M
SUBJECT: Flood Control at Chaska, Minnesota, Design Memorandum No. 3, Stage 3, East Creek

27. Dice 26. Concur; The real estate M-CACES data has been changed to properly reflect appropriate information and was coordinated with CENCS-PE-C to assure uniformity throughout. See revised page H-5 and page H-5a.

28. Dice 27. Concur; The real estate Attorney's Opinions of Compensability required for the project have been identified and are in the process of being completed.

FOR THE COMMANDER:

John J Bailen

for ROBERT F. POST, P.E.
Chief, Engineering & Planning Division

4 Encls
1-2 nc
Added 1 encl
3-4.as

CENCD-PE-ED-TM (CENCS-ED-M/13 Dec 93) (1110-2-1150a) 3d End
Mr. Ordonez/mgb/(312) 353-9057
SUBJECT: Flood Control at Chaska, Minnesota, Design Memorandum No. 3, Stage 3, East Creek

Commander, North Central Division, U.S. Army Corps of Engineers, 111 North Canal Street, Chicago, IL 60606-7205

22 MAR 1994

FOR Commander, St. Paul District, ATTN: CENCS-PE-M

1. Responses to comments are satisfactory. Two additional comments are enclosed which are advisory in nature. These comments are in relation to two technical subjects addressed in your responses. No further response is required and the subject DM is approved.

2. The HQ, NCD, POC is Mr. Jose Ordonez, CENCD-PE-ED-TM, (312) 353-9057.

FOR THE COMMANDER:

for [signature]
JOHN P. D'ANIELLO, P.E.
Director, Engineering and
Planning Directorate

5 Encls
1-4. nc
Added 1 encl
5. as

CF (w/encls and 7 cys of DM):
CECW-EP-E

CENCD-PE-ED-TM (1110) 27 January 1994

CENCD Comments
Chaska, MN, DM No. 3, Stage 3
East Creek Diversion

ED-TG (Simpson, 312-886-6935)

1. Page D-4, para. 9.

a. Discuss the location of the cutoff trench. It could be better to place this trench near the riverward toe in order to limit uplift under the riverward slope.

b. Discuss if a total cutoff could block groundwater flow to the creek and increase the groundwater levels behind the levee.

2. Page D-5, para. 17. Consider the need for an inspection trench along the Engler Blvd. and Highway 17 road where their embankments are used as part of the levee system.

3. Page D-5, para. 19. Give approximate time of consolidation.

4. Page D-7, para. 29. Explain the consequences of blocking the 4 inch drains under the highway embankment.

5. Page D-9, para. 37 and elsewhere. Explain the 5 degree Phi value specified in the Q test results for CL levee fill.

6. Page D-13, para. 43. It would appear the 8.5 percent grade running from sta 0+00 to 3+75 which is underlain by OH and PT soils could be a critical slope and in need of more study and/or explanation of the analysis. Discuss if the following were taken into consideration:

(1) Since earth loadings will be reduced by approximately 25 feet of excavation the soil will probably swell and strength will decrease with time. It was also noted LL and PI soil values are greater than 60 and 35 respectively indicating a significant potential for swelling. If swelling is indeed a problem using undrained strength could be unsafe.

(2) The steady state groundwater flow coming out of the slope in the form of springs as described on page D-3, para. 8.

(3) The design water level atop and running down the articulated concrete slope and/or other live loads like ice. Such loadings would appear suddenly without allowing time for consolidation.

ENCL 2

(4) References for cut slope design are 1, page 569 of "Soil Mechanics" by Perloff and Baron and 2, DM-7, page 7.1-313.

7. Page D-14, para. 46 through 51.

a. Give estimated time - duration of necessary settlement so it can be used for construction scheduling.

b. Estimate and include gain of strength with consolidation.

8. Page D-19, para. 66. Consider alternative materials other than concrete for cutoffs under structures.

ED-WH (Occhipinti, 312-353-7132)

9. Page 3, para 10. The report mentions using the same 5,000 gpm pump at Pond D and Outlet A. Will the current design allow for using the same pump or will a pump be required at both locations at the same time?

10. Page B-2, Table B-1. This table should appear after the discussion of the design considerations of the articulated mat (Paragraph B-5.)

11. Page B-3, Table B-2. Unit discharge should be listed as cfs/ft of width.

12. Page B-6, Table B-4. Include the average velocity for the design water surface on this table.

13. Page B-9, para B-16. The equation should be corrected to:

y = (CV2W)/(gr)

14. Page B-13, para B-24. We concur with reducing the number of stone gradations to ease construction. At the Stoughton Avenue Bridge consider reducing the thickness to less than 36 inches.

15. Page B-17, Table B-22. List the bridge locations on this table.

16. Page C-13, para 12. The report states that a USGS quad sheet was used to determine the normal elevation of Courthouse Lake. What would be the consequences of this elevation being incorrect by one-half of a contour interval?

17. Page C-21, para 33. This paragraph starts out claiming that changes to the HEC-1 and HEC-2 programs resulted in the design changes. The remainder of the paragraph talks about refinements to the HEC-1 and HEC-2 models. Please clarify.

ED-TM (Ordonez, 312-353-9057)

18. Page 14, para 47. The current estimates of project cost and benefits should be done in accordance with ER 1105-2-100, paragraph 5-18.

19. Plate B-1. This type of drop structure has been rejected by the District at the Basset Creek (Fruen Mill) project because of safety concerns. Explain why this is not a concern in this project.

RE (Dice, 312-353-7445)

20. Ponding area requirements are discussed on page 3, paragraphs 9 and 10, and in Appendix C, Interior Flood Control, page C-19, paragraphs 28 and 29. Appendix C, paragraph 29, states that "the estimated amount of real estate required at the Old Clay Hole, Courthouse Lake, and Outlet D Pond sites will be about 15, 12, and 11 acres, respectively". The standard estate required for a ponding area would be a flowage easement.

Based on the acreage and estates identified in the Real Estate Requirements Section, pages 9 and 10, the estimate of real estate costs does not include ponding areas. An informal telecon with NCSRE-A indicated that it was believed that the real estate requirements for the ponding areas were included in another DM. This should be confirmed or adjustments made, as necessary.

21. Page 9, paragraph 38 states that this stage of the project consists of approx. 35.3 acres of permanent levee and channel easement; however, the acreages shown in paragraph 39 for these easements totals only 31.86. If the 35.3 acreage figure is correct, the cost estimates shown in paragraph 39 need to be corrected. Adjustments should be made, as necessary.

22. Page 9, paragraph 39: Contingencies are not "compensation" for errors or omissions. This paragraph should be revised to reflect guidance in ER 405-1-12, Draft Chapter 12, para. 12-9.d.

23. Page 10, Relocation Assistance: Costs identified include acquisition of three residences. The estimated value of the residences should not be shown as a relocation assistance payment, but rather should be included as part of the total lands and damages estimate for the estates being acquired. Account 01.F., page H-5, should be revised appropriately to reflect only P.L. 91-646 relocation payments.

24. Page 10, Relocation Assistance: The discussion of the modular/mobile homes indicates they are "permanently affixed". Are the homes considered real estate and, if so, does the estimated lands and damages include the value of the improvements?

25. Page G-5, paragraphs 15 and 16, indicate that offsite disposal areas will be provided by the local sponsor. However, based on the estates identified in the Real Estate Requirements Section, it does not appear that the estimate includes lands required for disposal. If a real estate interest is to be acquired for disposal areas, the Real Estate Requirements Section and the cost estimates on page H-5 should be revised accordingly.

26. The Local Sponsor and the Federal administrative acquisition costs shown on page 10 do not match up with the total of the administrative costs reflected on page H-5. Also, there are no administrative costs shown for Local Sponsor or for Federal for account 01.F., P.L. 646 relocations, page H-5. It may be that the costs were included on page 10 but not properly distributed on page H-5. Revise/adjust accordingly.

27. There are several utility/facility relocations required for this stage of the project, which require Attorney's Opinions of Compensability by a real estate attorney. A discussion of the Attorney's Opinions of Compensability should be in the Real Estate Requirements Section of the report.

CONSTRUCTIBILITY

36. Appendix G contains a discussion on the construction aspects of this project.

REAL ESTATE REQUIREMENTS

37. The City of Chaska will provide, without cost to the United States, and as generally provided by the Local Cooperation Agreement, all real estate interests, to include borrow and disposal areas, required for the construction, operation, and subsequent maintenance of the project. The City will also comply with all provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (Public Law 91-646, as amended).

38. This stage of the Chaska Flood Control project will consist of approximately 35.3 acres of Permanent Levee and Channel Easement, 3.91 acres of Fee title for recreational trails, and 1.25 acres of temporary easement. A Single Family Residence (SFR) at 1100 Stoughton Ave., 1503 Parallel St., and 1509 Parallel St. are estimated to be removed for project purposes. Eight permanently set mobile homes will be displaced by the project. Damages to the remainder are estimated as a percentage of the fee value. Taken into consideration in estimating the damages is the shape of the remainder, additional cloud on the title and triangulation of the remainder of the parcel.

39. Contingencies are estimated as a percentage of the total lands and damages.

REAL ESTATE ESTIMATE

Estimate of Cost (date of value) 27 October 1993

FEE Title:				
By land Classification				
Industrial	.55 ac	$87,120	=	**$47,916**
Residential	1.10 ac	$64,000	=	**$70,400**
Agricultural	1.58 ac	$ 1,000	=	**$ 1,580**
Flood Plain	.21 ac	$ 100	=	**$ 21**
Public Use	.48	$ -0-	=	**$ -0-**
Total Fee Title				**$119,917**
Permanent Levee/ Channel Easement				
By land Classification				
Industrial	6.53	$87,120	=	**$568,894**
Residential	2.90	$64,000	=	**$185,600**
Agricultural	13.14	$ 1,000	=	**$ 13,140**
Flood Plain	4.04	$ 400	=	**$ 1,616**
River Bank/Ch	2.41	$ 100	=	**$ 241**
Public Use/Rdwy	2.36	$ -0-	=	**$ -0-**
Total Levee/Channel Easement				**$769,491**
Estimated at 80% of Fee				**$615,600**

ENCL 3

Temporary Easement				
Flood Plain (calculated at 10% of FEE)	1.25 ac	$ 400	=	$ 50
Total Lands				$735,567
Damages estimated at 25% of Fee Value				$222,400
Total Lands and Damages				$958,000
Contingencies (15%)				$144,000
Total Lands and Damages w/contingencies				$1,102,000

RELOCATION ASSISTANCE

Single Family Residences

1100 Stoughton Avenue - Assessed value $61,500 assumed 20% lower than FMV Estimated value $73,800
Relocation Assistance $22,500
Total for 1100 Stoughton Ave. $96,300

1503 Parallel Street - Assessed value Unable to determine - was not in cty records Estimated value $80,000
Relocation Assistance $22,500
Estimated total for 1503 Parallel St. $102,500

1509 Parallel Street - Assessed value $75,500 assumed 20% lower than FMV Estimated value (Apt hse) $90,600
Relocation Assistance $22,500
Estimated total for 1509 Parallel St. $113,100

Modular/Mobile Homes

Eight permanently affixed mobile homes to be removed from the take area with anticipated relocation assistance are estimated at $20,000 each $160,000

Administrative acquisition costs

Local Sponsor $54,000
Federal $29,300

PROJECT TOTAL (ESTIMATED) (ROUNDED) **$1,657,000**

MEASURES FOR PHYSICAL SECURITY

40. Hatches at the gatewells would be secured with locks to prevent the public from entering. The gatewells will have railings around them to prevent falls from them. Public access to the tops of levees and pedestrian trail by vehicles will be prevented by removal guard post.

REVISED
REAL ESTATE COST ESTIMATE
FOR
CHASKA STAGE III FLOOD CONTROL PROJECT

1. Revised plans have been provided by ED-D, Matt Bray with a request to provide an updated cost estimate for Stage III of the Flood Control Project in Chaska, Minnesota.

2. It is understood that the City of Chaska will provide, without cost to the United States Government, U.S. Army Corps of Engineers and as generally provided by the local cooperation agreement, all real estate interests, to include borrow and disposal areas, required for the construction, operation, and subsequent maintenance of the project. The city will also comply with all provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, as amended.

3. The revised Stage III flood control project will consist of approximately 35.3 acres of Permanent Levee and Channel Easement, 3.91 acres of Fee title for recreational trails, and 1.25 acres of temporary easement.

4. The real estate requirements were estimated from drawings and acreage provided to the Real Estate Division by ED-D.

5. A SFR at 1100 Stoughton Ave., 1503 Parallel St., and 1509 Parallel St. are estimated to be removed for project purposes.

6. Eight permanently set mobile homes will displaced by the project.

ASSUMPTIONS, LIMITATIONS, AND CLARIFYING STATEMENTS

1. This is a revision of the Real Estate Cost Estimate prepared and submitted on 23 October 1993.

2. Maps provided by ED-D do not distinguish between levee and channel easement, therefore the estimate for the channel and levee easement are the same.

3. Single family residences located at 1100 Stoughton Ave., 1503 Parallel Street and 1509 Parallel Street are privately owned and will need to be removed for project purposes.

4. That the various land classifications are estimates prepared by the appraiser from maps provided by ED-D.

5. Damages to the remainder are estimated as a percentage of the fee value. Taken into consideration in estimating the damages is the shape of the remainder, additional cloud on the title and triangulation of the remainder of the parcel.

ENCL #4

6. Contingencies are estimated because of the methods employed to arrive at values, unknown acreages due to meander of the river, no known boundary lines or ownership information, type of improvements involved in the take area, amount of elapsed time before the project may become a reality and other unknown elements that are not considered in this estimate.

REAL ESTATE ESTIMATE

Estimate of Cost (date of value) 27 October 1993

FEE Title:				
By land Classification.				
Industrial	.55 ac	$87,120	=	$47,916
Residential	1.10 ac	$64,000	=	$70,400
Agricultural	1.58 ac	$ 1,000	=	$ 1,580
Flood Plain	.21 ac	$ 100	=	$ 21
Public Use	.48	$ -0-		$ -0-
Total Fee Title				$119,917
Permanent Levee/Channel Easement				
By land Classification				
Industrial	6.53	$87,120		$568,894
Residential	2.90	$64,000		$185,600
Agricultural	13.14	$ 1,000		$ 14,720
Flood Plain	4.04	$ 400		$ 1,616
River Bank/Ch	2.41	$ 100		$ 241
Public Use/Rdwy	2.36	$ -0-		$ -0-
Total Levee/Channel Easement				$769,491
Estimated at 80% of Fee				$615,600
Temporary Easement				
Flood Plain	1.25 ac	$ 400 calculated at 10% of FEE		$ 50
Total Lands				$735,567
Damages estimated at 25% of Fee Value				$222,400
Total Lands and Damages				$958,000
Contingencies (15%)				$144,000
Total Lands and Damages w/ contingencies				$1,102,000

RELOCATION ASSISTANCE

Single Family Residences

1100 Stoughton Avenue - Assessed value $61,500 assumed 20% lower than FMV Estimated value $73,800

Relocation Assistance $22,500

Total for 1100 Stoughton Ave $96,300

1503 Parallel Street - Assessed value Unable to determine - was not in county records. Estimated Value $80,000

Relocation Assistance $22,500

Estimated total 1503 Parallel St. $102,500
1509 Parallel Street - Assessed value $75,500 assumed 20% lower than FMV Estimated value (Apt house) $90,600
Relocation Assistance $22,500
Estimated total 1509 Parallel St. $113,100

Modular/Mobile Homes
Eight permanently affixed mobile home to be removed from the take area with anticipated relocation assistance are estimated at $20,000 each $160,000

Administrative acquisition costs
Local Sponsor $54,000
Federal $29,300

PROJECT TOTAL (ESTIMATED) (ROUNDED) $1,657,000

SUMMARY OF REAL ESTATE COSTS

LAND				
FEE				
Industrial	.55	$87,120	$47,916	
Residential	1.10	$64,000	$70,400	
Agricultural	1.58	$ 1,000	$ 1,580	
Flood Plain	.21	$ 100	$ 21	
Public Use	.48	$ -0-	$ -0-	
Total Fee Land				$119,917
Permanent Levee/Channel Easement				
Industrial	6.53	$87,120	$568,894	
Residential	2.90	$64,000	$185,600	
Agricultural	13.14	$ 1,000	$ 14,720	
Flood Plain	4.04	$ 400	$ 1,616	
River Bank/Ch	2.41	$ 100	$ 241	
Public Use/Rd	2.36	$ -0-	$ -0-	
Total			$769,491	
Estimated at 80% of Fee				$615,600
Improvements to Real Property				
1100 Stoughton Avenue			$73,800	
1503 Parallel Street			$80,000	
1509 Parallel Street			$90,600	
8 Mobile Homes			$96,000	
Total Improvements				$340,400
Temporary Easement				
Flood Plain	1.25	$ 400		$ 50
Minerals				$ -0-
Timber				$ -0-
Damages estimated at 25%				$222,400
ADMINISTRATIVE ACQUISITION COSTS				
Local Sponsor			$54,000	
Federal			$29,300	
Total Administrative Costs				$83,300
RELOCATION ASSISTANCE				
1100 Stoughton Avenue			$22,500	
1503 Parallel Street			$22,500	

1509 Parallel Street	$22,500
8 Mobile Homes	$64,000
Total Relocation Assistance	$131,500
CONTINGENCIES	
Estimated at 9.5%	$143,750
PROJECT TOTAL ESTIMATED	**$1,656,920**
ROUNDED	**$1,657,000**

Larry R. Joachim
Chief, Appraisal Branch
Real Estate Division

CENCD-PE-ED-T

1. Response to Simpson comment 2. The implication that the wide levees will dissipate the under seepage pressures more effectively than the narrower levees is for practical purposes not true. A wide levee merely transfers the pressures under the levee further landward. See your own computations for the levees at Houston, and the mathematical derivations by Doug Spaulding (Case 5),
located some where in your own files.

2. Response to Simpson comment 5. There will be times when the levees are saturated even though there is no flood. This is particularly true during the spring thaw when groundwater is high, snow is melting, and the frost is going out. This is also the time when the most flooding occurs. If saturated soils are a stability problem, than design for saturated soil strengths. Rethink the ϕ=Zero concept, if appropriate.

Encl 5

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
190 FIFTH STREET EAST
ST. PAUL, MINNESOTA 55101-1638

13 December 1993

REPLY TO
ATTENTION OF

CENCS-ED-M (1110)

MEMORANDUM FOR: Commander, North Central Division, ATTN: CENCD-PE-ED, 111 North Canal Street, Chicago, Illinois 60606-7205

SUBJECT: Flood Control at Chaska, Minnesota, Design Memorandum No. 3, Stage 3, East Creek

1. Subject report is submitted in accordance with ER 1110-2-1150 for your review and approval.

2. This design memorandum presents the design improvements for construction of the East Creek Diversion Channel, levee at East Creek, and related structures as well as recreational features for the flood control project at Chaska, Minnesota.

FOR THE COMMANDER:

Encl (16 cys)
Chaska Stage 3 DM

ROBERT F. POST, P.E.
Chief, Engineering Division

FLOOD CONTROL
EAST CREEK AT
CHASKA, MINNESOTA

DESIGN MEMORANDUM NO. 3

MINNESOTA RIVER

DESIGN MEMORANDUM SCHEDULE

Number	Scheduled Completion	Submitted NCD	Submitted OCE	Approved
General	Mar 84	6 Mar 84	May 84	Jul 84
1. Chaska Creek (Stg 2)	Jul 84	Dec 84	Feb 85	Aug 85
2. Minnesota Rvr (Stg 4)	Mar 91	24 Apr 91	12 Aug 91	12 Aug 91
3. East Creek (Stg 3)	Dec 93			

EXECUTIVE SUMMARY

The Chaska, Minnesota Flood Control project was authorized for construction by Section 102 of the 1976 Water Resources Development Act, Public Law 94-587. Chaska is on the Minnesota River in Carver County in south-central Minnesota about 20 miles southwest of Minneapolis-St. Paul.

The flood control project provides flood protection to Chaska by diverting both Chaska and East Creeks and by providing a levee that protects against flooding by the Minnesota River. The creek diversions provide protection for about a 5500 cfs flow and the levee provides one-percent chance flood protection. Pertinent data is on the following page.

The total estimated project cost is $42,400,000. Federal costs are estimated at $30,000,000; non-Federal costs are estimated at $12,400,000. The estimated cost for Stage 3, East Creek is $16,456,000. Federal cost for Stage 3 are estimated at $10,649,000; non-Federal costs are estimated at $5,807,000.

The Local Cooperation Agreement was executed in September 1988. The Stage 1 construction contract was awarded in September 1988. The Stage 2 construction contract was awarded in August 1989. The Stage 4 construction contract was awarded in March 1993. Stage 3 is scheduled for a construction contract award in February 1995.

This Design Memorandum presents the recommended design for Stage 3, East Creek Diversion. The design includes four drop structures, articulated concrete channel, trapezoidal riprap channel, two 12' x 12' box culverts, three roadway bridges, landscaping, recreation trail, two outlets with gatewells and the remaining Stage 4 levee at the East Creek intersection.

PERTINENT DATA

Project Document - House Document 94-644, 94th Congress, 2nd Session.

Project Authorization - 1976 Water Resources Development Act (Public Law 94-587).

Project Purpose - Flood Control.

Location - The project is located on the Minnesota River in Carver County and Chaska, Minnesota, and includes both Chaska and East Creeks, which are tributaries of the Minnesota River.

Hydrology and Hydraulics

Watershed Drainage Area	
Chaska Creek Diversion Inlet	14.9 Square Miles
East Creek Diversion Inlet	10.1 Square Miles
Minnesota River	16,600 Square Miles
Design Flows	
Chaska Creek Diversion	5,550 cfs
East Creek Diversion	5,500 cfs
Minnesota River	168,000 cfs (1 percent exceedence frequency event)

Principal Items of Work

Diversion Channel	
Stage 2	5,800 LF
Stage 3	6,000 LF
Levee Improvement	
Stage 2	2,100 LF
Stage 4	4,200 LF
New Levee, Stage 4	2,800 LF
Drop Structures, Stage 3	4
Pumping Station, Stage 4	1
Bridges	
Stage 2	4
Stage 3	3

Economics Oct 83

Federal first cost	$23,200,000
Non-Federal first cost	9,500,000
Total first cost	32,700,000
Average annual operation & maintenance cost	37,400
Total average annual cost	2,948,000
Average annual benefits	2,289,000
Benefit-cost ratio	.78

EAST CREEK AT CHASKA, MINNESOTA
STAGE 3 FEATURE DESIGN MEMORANDUM
FLOOD CONTROL PROJECT

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EAST CREEK AT CHASKA, MINNESOTA
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FLOOD CONTROL PROJECT

MAIN REPORT

SCOPE AND LOCATION

1. The flood control project at Chaska, Minnesota is divided into four stages of construction. This Design Memorandum (DM) presents the design and discussion of planning for Stage 3 which, in general, consists of a diversion channel that protects Chaska from flooding of East Creek. Work to be done includes approximately 5300 feet of riprap channel, 350 feet of grass lined channel, 380 feet of articulated concrete channel, one inlet structure, four drop structures, two outlets with gatewells, 200 feet of levee, 630 feet of 12' x 12' box culvert, three bridges, and two sanitary lift stations.

PROJECT AUTHORIZATION

2. This project was authorized for construction under Public Law 94-587.

PROJECT DESCRIPTION - GENERAL

3. The Chaska Flood Control project consists of the following four stages:

a. Stage 1, Road raise along Chaska Creek.
b. Stage 2, Chaska Creek Diversion Channel.
c. Stage 3, East Creek Diversion Channel.
d. Stage 4, Minnesota River Levee.

Also included are recreational improvements, an environmental mitigation plan, and aesthetic consideration.

DEPARTURES FROM APPROVED GENERAL DESIGN MEMORANDUM

4. The design presented here essentially conforms to that shown in the General Design Memorandum, Supplement No. 2, dated 21 December 1989. Exceptions include:

a. The bridge proposed at the Highway 41/East Creek intersection has been changed to two 12' x 12' box culverts.

b. The downstream portion of the diversion channel has been changed from a concrete and riprap channel to a riprap and articulated concrete channel.

c. The diversion channel design flow is 5500 cfs whereas the current SPF is estimated at 6100 cfs. See Appendix A for additional information.

d. The residual damages downstream of the point of diversion adjacent to the existing East Creek have been eliminated. See Appendix C.

ALTERNATIVE PLANS CONSIDERED

5. Other plans considered include:

a. Drop structure at about Station 46+00 instead of at Station 33+00.

b. Concrete U-structure channel from about Station 9+00 to 33+00 instead of riprapped channel.

c. Concrete drop structure at the confluence of the Minnesota River, Station 0+00, instead of the articulated concrete.

VALUE ENGINEERING

6. The current channel alignment is the result of a VE study that was performed on the GDM in 1989. An additional VE study is scheduled to be performed on this approved DM approximately February 1994.

DESCRIPTION OF PROPOSED STRUCTURES

CHANNEL (Plates 2 - 8)

7. The diversion channel consists of the following, starting at the downstream end:

a. Approximately 380 feet of articulated concrete channel.
b. Approximately 350 feet of grass lined channel.
c. Approximately 100 feet of riprap channel.
d. Concrete drop structure.
e. Approximately 600 feet of riprap channel.
f. Concrete drop structure.
g. Approximately 1700 feet of riprap channel.
h. Concrete drop structure.
i. Approximately 1800 feet of riprap channel.
j. Concrete drop structure.
k. Approximately 700 feet of riprap channel.

Additional descriptions of the channel and concrete structures are contained in Appendixes B and E. Additional descriptions of the designs are contained in Appendix A - Hydrology, Appendix B -

Hydraulic, Appendix C - Interior Flood Control, Appendix D - Geotechnical, Appendix E - Structural, Appendix F - Recreation, Landscape Development & Aesthetic Considerations and Appendix J - Hwy 41/East Creek Relocations.

LEVEE (Plate 9)

8. The levee construction will consist of about 200 feet of new levee about 25 feet high. This levee will complete the levee constructed under Stage 4. The levee design is discussed in Design Memorandum No. 2, dated March 1991, Appendixes B and C.

PONDING AREA (Plates 10 & 11)

9. A storm water ponding area at Outlet D will be provided. This ponding area will be in and adjacent to the existing East Creek just upstream from Outlet D. The house across East Creek from Courthouse Lake and about 800 feet west of the proposed levee currently has a dike with gated outlets that protect it from flooding of the Minnesota River. This dike and gates will protect it from flooding from the ponding area. However, their small pump will continue to be required to remove seepage resulting from an existing spring.

10. The sides slopes of the ponding area just upstream from Outlet D, will be graded, topsoiled and seeded so that the area can be maintained. Ponding markers will be added as required. Additional discussion on the ponding area is contained in Appendix C. A portable 5000 gpm pump will be provided to limit ponding levels at Pond D during rare events such as the summer flood of 1993. This pump can also be used at the ponding area constructed during Stage 4 on Chaska Creek at Outlet A. Some pumping was required at Pond A during the 1993 flood.

OUTLETS (Plates 8, 9, 31 - 35)

11. Two gated outlets with gatewells will be required. Outlet D will be constructed in the proposed levee to allow normal low flows from East Creek to pass through the levee. During high flows on the Minnesota River the sluice gate will be closed and water from East Creek will pond in the ponding area.

12. Outlet E will be constructed at the upstream end of the Stage 3 diversion channel. This outlet will allow normal low flows to pass through Chaska. When the Outlet E capacity is exceeded, the excess water will begin ponding to a depth of 5 feet and then begin flowing down the diversion channel. When rising Minnesota River flows indicate that Outlet D will need to be closed, Outlet E will be closed in advance.

LANDSCAPING

13. The levee, channel and surrounding project area will be restored and landscaped. The location and proximity of the surrounding residential or other land uses dictate the need for vegetative screening and provisions for enhancing or directing views. Design consideration include the ease of maintenance and the incorporation of plant material that will offer seasonal color, bloom, fruit, hardiness, and wildlife shelter and food values. Additional considerations will be providing shade for trail users and maintaining plant selections that are consistent with Stage 2 and 4. The levee will have turf grasses established.

RECREATION

14. A multi-use trail will be provided along the channel. It will consist of an 8-foot wide bituminous surface with 1-foot wide aggregate shoulders. In the vicinity of Courthouse Lake, (Stage 4 levee construction) at approximately Station 29+00, a bituminous surfaced trail will be constructed linking the levee-top trail with a trail constructed around Courthouse Lake. From approximately Station 29+00 to Station 0+00 the levee-top trail's surface will be stabilized aggregate during Stage 4 construction, with a bituminous trail added during Stage 3 construction. Safety rails will be provided as appropriate. A parking lot with one informational kiosk will be provided. The recreation trail will be fully accessible by mobility impaired visitors with the appropriate slopes and landings provided at major access points.

RELOCATIONS

UTILITIES

15. As provided in the Local Cooperation Agreement (LCA), the Local Sponsor shall "accomplish or arrange for accomplishment at no cost to the Government of all alterations and relocations of buildings; highways; railroads; bridges (other than railroad bridges and approaches thereto); storm drains; utilities (other than those portions which pass under or through the project structures); cemeteries; and other facilities, structures, and improvements determined by the Government to be necessary for construction of the project."

16. A table indicating the required utility modifications is given in Appendix G.

SANITARY SEWER AND LIFT STATION

17. Existing sanitary sewers cross the diversion channel at Stoughton Avenue and Highway 212. Two sanitary lift stations will be constructed in these areas along with appropriate sanitary piping. This construction is classified as a relocation and as

such is the Local Sponsor's responsibility to accomplish and pay for the design and construction. However, Chaska will be given the option of:

a. Designing and constructing the relocation.

b. Designing the relocation and having it constructed with the Stage 3 flood control construction contract.

c. Having it designed with the Stage 3 plans and specifications and having it constructed with the Stage 3 flood control construction contract.

18. Chaska's future development will require construction of a new trunk sanitary sewer from north of Outlet E to the current sanitary treatment plant in the area of Courthouse Lake. Either the abandoned Highway 17 right-of-way will be used or an additional strip of land adjacent to and west of the diversion channel right-of-way will be acquired by Chaska.

BRIDGES

19. Three bridges will be required. They will be at the following locations and of the following types:

a. Stoughton Ave. - 3 span, prestressed concrete beams.
b. Highway 212 - 3 span, prestressed concrete beams.
c. Engler Boulevard - 3 span, steel beams.

ROADS

20. The Highway 41 roadway relocation is discussed in Appendix J. It consists of two 12' x 12' box culverts, debris barrier and energy dissipator. The plan shown in Appendix J includes the construction required to accommodate the Minnesota Highway Department's future Highway 212 by pass plans. The completed roadway shown is higher and wider than the existing roadway.

PERMITS

21. Permits required for project construction include a Minnesota Department of Natural Resources Protected Waters Permit and a National Pollutant Discharge Elimination System (NPDES) permit for construction activities. The City of Chaska will obtain the Protected Waters Permit. The Corps and General Contractor will obtain the NPDES Permit. NPDES permit requirements for erosion control will be incorporated into the plans and specifications. Other miscellaneous permits at the local and State level will be obtained by the City and/or General Contractor.

ENVIRONMENTAL ANALYSIS

ENVIRONMENTAL SETTING

22. Land use along this reach of the project is a mix of residential development, commercial development, undeveloped lands and cropland. The inlet of the diversion channel is located in a residential area that is primarily a trailer park. Most of the channel is located in open fields. Some light industrial development and a nursery are adjacent to the channel alignment on the upstream end. The lower 1600 feet of the channel runs adjacent to the Crystal Sugar facilities. The floodplain of the Minnesota River is composed of a mix of riparian woods and floodplain wetlands. Riparian woods vegetation includes silver maple, American elm, box elder, cottonwood and willow with an understory of nettle, jewelweed and grasses.

23. A fen is located immediately to the east of the proposed channel. A fen is a type of wetland supported by groundwater discharge such as springs and seepages. The fen is about 5 acres in size and is fairly diverse in nature. During a recent survey four plant communities were identified within this fen: sedge meadow, shallow marsh, shrub-carr and lowland hardwood forest. The sedge meadow is dominated by tussock sedge and Canada bluejoint grass. Prairie sedge, marsh fern, asters and goldenrods are also present. The shallow marsh is dominated by lake sedge, cattail and reed canary grass, with marsh marigold and jewelweed as common forbs. The shrug-carr is dominated by willows and the lowland hardwoods are typical of riparian woods in the area.

24. An Environmental Site History was conducted for the proposed channel alignment to assess the potential of encountering contaminated soils during construction. A review of insurance maps, directories, aerial photos, data bases and a site survey did not indicate any potential for contaminated soils along the channel alignment.

ENVIRONMENTAL SITE ASSESSMENT

25. The Environmental Site Assessment for the East Creek Diversion channel is titled "Contaminated Materials and Groundwater Investigation Work Plan", and is contained in Supplement 3 to the General Design Memorandum, dated September 1992.

ENVIRONMENTAL IMPACTS

26. Construction of the proposed features will result in the loss of approximately 3 acres of grassland, 8 acres of cropland, and 3 acres of wooded areas. The trees that would be lost are located primarily in the residential area that will be relocated at the inlet. Habitat losses to wildlife with project construction were partially mitigated with the planting of upland vegetation on project lands in conjunction with the construction of Stage 2 along

Chaska Creek. Shrubs and shrubby tree species such as dogweed, hazel and russian olive along with oak, wildplum, chokecherry, maple and ash were planted and will be managed for wildlife.

27. Mitigation for losses associated with construction of this and other stages of the project will be provided with the construction of fish and wildlife features on the Minnesota Valley National Wildlife Refuge. The features include the construction of an outlet control structure for Chaska Lake and the construction of a 16 acre moist soil unit just to the east of Chaska Lake. The outlet control structure will provide the capability to manipulate water levels on the lake to control aquatic vegetation. The moist soil unit will be managed to provide feeding habitat for waterfowl. The area will be created by diking a 16 acre site that is currently cropland. The system will consist of two cells that can be flooded to a depth of about 2 feet and managed independently. This feature will be constructed concurrently with Stage 4 of the project.

28. The outlet for the diversion channel is routed through an old lime settling pond that was used in the processing of sugar beets. The pond is now abandoned and is filled to height of about 15 feet with lime. The lime is occasionally mined by the current owners and sold to the surrounding agricultural community for soil adjustment. This alignment was selected to avoid the fen complex immediately to the east of the proposed channel.

29. The impacts of the Chaska Flood Control Project were described in the Final Supplement to the Final Environmental Impact Statement, dated August 1982 and the Final Supplement II, dated February 1985. Design departures from what was described in the General Design Memorandum have been evaluated. The proposed channel alignment, although similar to the one discussed in the 1982 Supplement, is a substantial departure from the selected plan described in the Final Supplement II. Therefore, an environmental assessment has been prepared addressing this change in project design. The assessment concludes that the impacts of the proposed channel alignment and design would not substantially differ in type or magnitude from what was described in earlier NEPA documents. No additional mitigation would be required with the proposed channel feature.

CULTURAL RESOURCES

30. In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, the National Register of Historic Places has been consulted. A standing structure survey of Carver County conducted for the Minnesota State Historic Preservation Office in 1978 recorded 23 historic National Register buildings and one National Register district in the City of Chaska. As of 1 July 1992, there are no sites listed on or eligible or inclusion on the National Register that will be affected by the proposed Stage 3. The trailer houses to be removed are all less than 50 years old. The private residences to be removed have been

evaluated as being not eligible for listing on the National Register. As a result, there will be no effect on significant historic properties if any of these buildings are removed as proposed.

31. The Stage 3 diversion channel alignment was surveyed for cultural resources in 1991 in conjunction with a survey of the Stage 4 levee alignment and moist soil unit. No cultural resources were encountered along the Stage 3 alignment either on the surface or below it in power auger tests drilled to a maximum depth of 8 meters (ca. 26 feet). The Minnesota State Historic Preservation Office concurs that "no properties eligible for or listed on the National Register of Historic Places are within the project's area of potential effect" (letter from MN SHPO, dated 16 December 1991).

32. The proposed Stage 4 borrow area, which will also be used for Stage 3, has likewise been cleared from a cultural resources standpoint. A cultural resources survey of the Kusske borrow pit during April 1992 encountered only one small chipped stone flake from the plowzone during shovel-testing. Based on the results of the survey, the Minnesota State Historic Preservation Office has concluded that "no properties eligible for or listed on the National Register of Historic Places are within the area of potential effect" (letter from MN SHPO, dated 26 May 1992). Any additional or alternate borrow or disposal areas chosen for use for Stage 3 may need a cultural resources survey prior to their use. The need for and results of such surveys will be coordinated with the Minnesota State Historic Preservation Office.

CONSTRUCTION MATERIALS

GENERAL

33. Concrete aggregate, impervious and pervious fill, and topsoil can be obtained from commercial sources in the area. See Appendix D for additional discussion on construction materials.

LEVEE FILL

34. Impervious levee fill will be obtained from a commercial borrow area located about two miles from the project. This is the same borrow area provided by Chaska for the Stage 2 and 4 levee.

RIPRAP AND BEDDING

35. Riprap and bedding of adequate quality can be obtained from existing quarries located within 20 miles of Chaska.

CONSTRUCTIBILITY

36. Appendix G contains a discussion on the construction aspects of this project.

REAL ESTATE REQUIREMENTS

37. The City of Chaska will provide, without cost to the United States, and as generally provided by the Local Cooperation Agreement, all real estate interests, to include borrow and disposal areas, required for the construction, operation, and subsequent maintenance of the project. The City will also comply with all provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (Public Law 91-646, as amended).

38. This stage of the Chaska Flood Control project will consist of approximately 35.3 acres of Permanent Levee and Channel Easement, 3.91 acres of Fee title for recreational trails, and 1.25 acres of temporary easement. A Single Family Residence (SFR) at 1100 Stoughton Ave., 1503 Parallel St., and 1509 Parallel St. are estimated to be removed for project purposes. Eight permanently set mobile homes will be displaced by the project. Damages to the remainder are estimated as a percentage of the fee value. Taken into consideration in estimating the damages is the shape of the remainder, additional cloud on the title and triangulation of the remainder of the parcel.

39. Contingencies are estimated as a percentage of the total lands and damages to compensate for any errors or omissions.

REAL ESTATE ESTIMATE

Estimate of Cost (date of value) 27 October 1993

FEE Title:				
By land Classification				
Industrial	.55 ac	$87,120	=	$47,916
Residential	1.10 ac	$64,000	=	$70,400
Agricultural	1.58 ac	$ 1,000	=	$ 1,580
Flood Plain	.21 ac	$ 100	=	$ 21
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Agricultural	13.14	$ 1,000	=	$ 13,140
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River Bank/Ch	2.41	$ 100	=	$ 241
Public Use/Rdwy	2.84	$ -0-	=	$ -0-
Total Levee/Channel Easement				$769,491
Estimated at 80% of Fee				$615,600

Temporary Easement			
Flood Plain	1.25 ac	$ 400	= $ 50
(calculated at 10% of FEE)			
Total Lands			$735,567
Damages estimated at 25% of Fee Value			$222,400
Total Lands and Damages			$958,000
Contingencies (15%)			$144,000
Total Lands and Damages w/contingencies			$1,102,000

RELOCATION ASSISTANCE

Single Family Residences

1100 Stoughton Avenue - Assessed value $61,500 assumed 20% lower than FMV Estimated value	$73,800	
Relocation Assistance	$22,500	
Total for 1100 Stoughton Ave.		$96,300
1503 Parallel Street - Assessed value Unable to determine - was not in cty records Estimated value	$80,000	
Relocation Assistance	$22,500	
Estimated total for 1503 Parallel St.		$102,500
1509 Parallel Street - Assessed value &75,500 assumed 20% lower than FMV Estimated value (Apt hse)	$90,600	
Relocation Assistance	$22,500	
Estimated total for 1509 Parallel St.		$102,500

Modular/Mobile Homes

Eight permanently affixed mobile homes to be removed from the take area with anticipated relocation assistance are estimated at $20,000 each	$160,000

Administrative acquisition costs

Local Sponsor	$54,000	
Federal	$29,300	
PROJECT TOTAL (ESTIMATED)		$1,657,200

MEASURES FOR PHYSICAL SECURITY

40. Hatches at the gatewells would be secured with locks to prevent the public from entering. The gatewells will have railings around them to prevent falls from them. Public access to the tops of levees and pedestrian trail by vehicles will be prevented by removable guard post.

CORROSION MITIGATION

41. There is no evidence that corrosion due to the water and soils in the Chaska area is a problem. Therefore, no corrosion mitigation is planned.

WATER QUALITY

42. The fill materials placed in the river channel would be uncontaminated materials obtained from approved quarries and borrow areas. This should insure that water quality standards would not be violated because of project-related activities. Although some minor temporary increase of turbidity would occur during construction, levels of turbidity would return to normal after construction. No long term ponding of water or operational procedures that would effect water quality would be associated with the project.

43. To meet EPA/MPCA non-point pollution standards the Local Sponsor has investigated the impacts of the East Creek diversion channel on water quality. Their findings are included in a report titled "Stormwater Quality Improvements for Chaska East Creek and West Creek at Chaska Lake, Chaska, Minnesota", dated June 1993. Among the reports recommendations are:

a. Construction of a 3-cell sediment and Nutrient trap pond downstream of Outlet D.

b. Construction of two 2-cell sediment trap ponds upstream of Outlet E.

44. The provisions of Section 404 of the Clean Water Act have been met with the submission of the EIS Supplement, including a Section 404(b)(1) Evaluation, to Congress on 26 April 1982. The provisions of Section 404 were further met with the submission of the EIS Supplement No. 2, including a Section 404(b)(1) Evaluation in April 1985. The final EIS for Supplement No. 2 was filed in May 1985.

COST ESTIMATE

45. The cost estimate in this DM is based on current price levels and reflects recent prices for similar work done in the St. Paul District. The following table (Table 1) presents a cost estimate for Chaska Stage 3 and a comparison of the cost estimate with the current approved PB-3 estimate. It should be noted that the PB-3 estimate was based on a value engineering proposal, VE89-12, dated September 1989. That design, starting at the upstream end, included a riprapped channel with a 30-foot bottom width, flanked with levees from the existing creek to a 20-foot wide drop structure at Highway 17. Downstream of the drop structure, a 10-foot bottom width riprapped channel flanked with levees continued

approximately 1,700 feet. It then transitioned into a 35-foot wide supercritical concrete channel for 2,400 feet and ended in a concrete stilling basin approximately 600 feet from the Minnesota River. A riprapped channel to the River would then be provided. The Value Engineering budget estimate was reduced by approximately $1.7 million during further design stages due to the proposal of replacing the supercritical concrete channel with grass-lined and riprapped-lined channels, outlet D size reduction, and change of Highway 41 crossing from a bridge to box culverts. Groundwater problems resulted in changes to drop structure locations and channel geometry. Increased channel velocities eliminated the grass-lined channel. Also shown is an estimate of the local share of the costs. The cost sharing is in accordance with the 1986 Water Resources Development Act (Public Law 99-662). Appendix H contains the detailed cost estimate for this project.

ITEM	CURRENT APPROVED ESTIMATE FROM PB-3 (1 October 1993)	REVISED ESTIMATE THIS DM (1 October 1993)
First Cost Land and Damages	1,335,000	1,657,000
Relocations Federal		
Non-Federal	1,661,000	4,108,000 (1)
Levees and Floodwalls		522,000
Channels	7,802,000	7,099,000
Recreation Facilities	118,000	72,000
Plnng, Engnring & Dsgn	2,470,000	2,470,000
Construction Management	470,000	528,000
TOTAL FIRST COSTS	13,856,000	16,456,000
Federal/Non-Federal Federal First Cost Flood Control	10,328,000	10,607,000
Recreation	68,000	42,000
TOTAL	10,396,000	10,649,000
Non-Federal First Cost Flood Control	3,392,000	5,765,000
Recreation	68,000	42,000
TOTAL	3,460,000	5,807,000

TABLE 1: SUMMARY COMPARISON OF ESTIMATED FIRST COSTS

(1) Includes $150,000 for County Road 17 relocation; which deleted the County Road 17 bridge.

46. The difference in project first cost (an increase of $2,600,000) between this DM cost estimate and the current approved PB-3 is attributable to the following:

a. Price levels: None

b. Lands and Damages: +$322,000

(1) Increase based on alignment change and additional PL 91-646 assistance payments (110,000) and damage payments (212,000). +322,000

c. Relocations: +2,447,000

(1) Increase in bridge costs due to change from rectangular concrete channel to trapezodial riprap channel. +1,283,000

(2) Addition of Engler Ave Bridge (bridge was deleted in PB-3 estimate due to possibility of no Engler Ave extension by the city. City now has fixed schedule for Engler Ave extension. +854,000

(3) Increase due to more detailed utility relocation information. +310,000

d. Levees and Floodwalls: +522,000

(1) Levee work in PB-3 estimate was included in channel work. +522,000

e. Channels: -703,000

(1) Channel estimate has major changes due to revised geometry, materials, alignment, and detail. PB-3 estimate had levee work in channel estimate. -703,000

f. Recreation Facilities: -46,000

(1) Decrease based on more detailed plans and deletion of Engler Ave recreation trail underpass (trail now in channel under bridge). -46,000

g. Planning, Engineering and Design: No change.

h. Construction Management: +58,000

(1) PB-3 estimate based on 6% of construction. DM estimate based on 7.5% of construction. +58,000

CURRENT BENEFIT - COST ANALYSIS

47. The current Benefit/Cost analysis is based on the procedures used for updating project budgets. The last approved economic analysis of the Chaska Flood Control project was for the GDM, dated February 1984, and is in October 1983 prices. Project first costs ($42,400,000 Oct 93) have been deflated from October 1993 price levels to October 1983 price levels ($32,700,000 Oct 83) using the ENR construction costs index. The factor is 1.297. Interest during construction has been calculated using the same method as presented in the GDM report in which interest during construction is discontinued after completion of each stage.

FEDERAL	
First Cost	$23,200,000
Interest During Construction	1,820,000
Investment Cost	25,020,000
Annual Costs	2,064,900
NON-FEDERAL	
First Cost	9,500,000
Interest During Construction	750,000
Investment Cost	10,250,000
Annual Costs	845,900
Annual Operation and Maintenance	37,400
TOTAL INVESTMENT COST	32,705,000
Total Annual Cost	2,948,200
8.25% 100 year project life	
Int & amort factor (.08253)	
Annual Benefits	
Flood Control	2,260,900
Recreation	28,000
TOTAL	2,288,900
Benefit Cost Ratio	.78

TABLE 2: BENEFIT - COST ANALYSIS (All figures are in October 1983 price levels)

SCHEDULE FOR DESIGN AND CONSTRUCTION

DESIGN

48. Schedules for design and construction are based on the President's budget for Fiscal Year 1994. Plans and specifications are scheduled for completion in December 1994.

CONSTRUCTION

49. A continuing contract for East Creek Diversion channel construction is scheduled for award in February 1995. Completion of construction is scheduled for December 1996.

FUNDING SCHEDULE

50. On the basis of the revised estimate for this DM and the current schedule presented in the President's FY94 budget for completion of the project, the Federal funds required (by fiscal year) for construction are as follows:

a. Fiscal Year 1995 - $4,000,000

b. Fiscal Year 1996 - $5,100,000

c. Fiscal Year 1997 - $1,300,000

OPERATION AND MAINTENANCE

51. Under the terms of the Local Cooperation Agreement, the Local Sponsor will be responsible for the operation and maintenance (O&M) of the project. An O&M manual will be provided to the Local Sponsor prior to final acceptance of the project by the Local Sponsor.

RECOMMENDATION

52. I recommend the approval of the plan for Stage 3, East Creek, at Chaska, Minnesota, flood control project as presented in this DM.

JAMES T. SCOTT
COL, EN
Commander

DRAWING INDEX

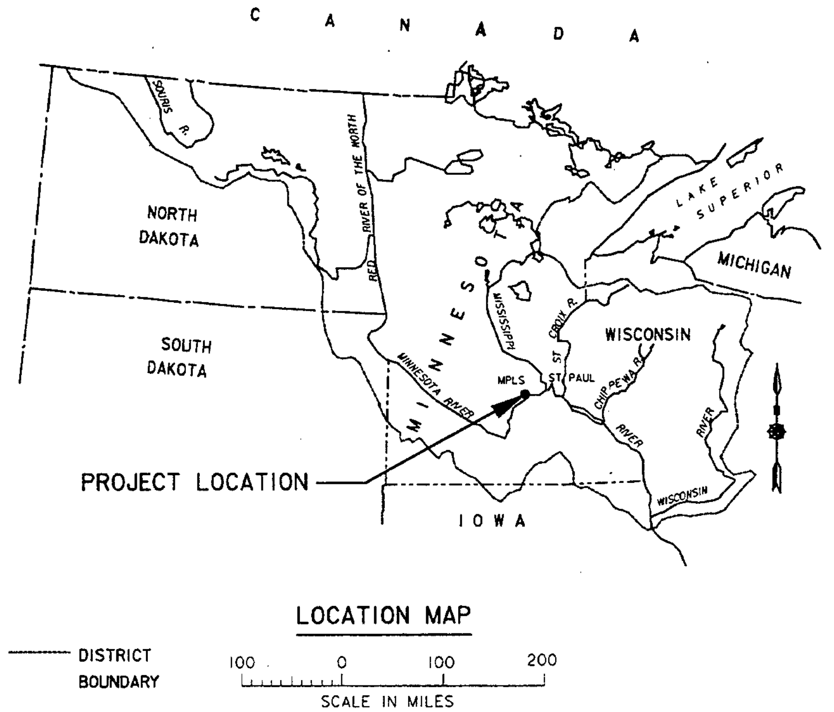
PLATE NO.	SHT.	DESCRIPTION	CAD FILE
		GENERAL	
PLATE 1	1	LOCATION MAP, VICINITY MAP, DRAWING INDEX	NC05P001.DGN
PLATE 2	2	GENERAL PLAN	NC05P002.DGN
PLATE 3	3	PLAN AND PROFILE STA. 0+00 TO STA. 10+00	NC05P003.DGN
PLATE 4	4	PLAN AND PROFILE STA. 10+00 TO STA. 20+00	NC05P004.DGN
PLATE 5	5	PLAN AND PROFILE STA. 20+00 TO STA. 30+00	NC05P005.DGN
PLATE 6	6	PLAN AND PROFILE STA. 30+00 TO STA. 40+00	NC05P006.DGN
PLATE 7	7	PLAN AND PROFILE STA. 40+00 TO STA. 50+00	NC05P007.DGN
PLATE 8	8	PLAN AND PROFILE STA. 50+00 TO STA. 60+00	NC05P008.DGN
PLATE 9	9	PLAN - OUTLET D	NC05P009.DGN
PLATE 10	10	PONDING SIGN DETAILS	NC05P10.DGN
PLATE 11	11	PONDING PLAN - OUTLET "D"	NC05P011.DGN
PLATE 12	12	TYPICAL SECTION - STA. -0+28 TO STA. 2+85	NC05P012.DGN
PLATE 13	13	TYPICAL SECTION - STA. 3+50 TO STA. 3+60	NC05P013.DGN
PLATE 14	14	TYPICAL SECTIONS - STA. 3+73 TO STA. 8+25	NC05P014.DGN
PLATE 15	15	TYPICAL SECTIONS - STA. 9+72 TO STA. 30+60	NC05P015.DGN
PLATE 16	16	TYPICAL SECTIONS - STA. 28+70 TO STA. 50+05	NC05P016.DGN
PLATE 17	17	TYPICAL SECTIONS - STA. 50+05 TO STA. 58+80	NC05P017.DGN
PLATE 18	18	TYPICAL SECTIONS - STA. 58+70 TO 58+80, OUTLET E & D	NC05P018.DGN
PLATE 19	19	MISCELLANEOUS DETAILS	NC05P019.DGN
		STRUCTURAL	
PLATE 20	20	DROP STR. 1 & RET. WALLS- PLAN, PROFILE, ELEV. & SECTION	NCSPRD1A.DGN
PLATE 21	21	DROP STR. 1 CUT OFF WALLS SECTIONS & TYP. DTLS.	NCSPRD1B.DGN
PLATE 22	22	DROP STR. 2 PLAN, PROFILE & SECTION	NCSPRD2A.DGN
PLATE 23	23	DROP STR. 2 & RET. WALLS - ELEVATIONS	NCSPRD2B.DGN
PLATE 24	24	DROP STR. 2 RET. & CUT OFF WALLS - SECTIONS	NCSPRD2C.DGN
PLATE 25	25	DROP STR. 3 PLAN, PROFILE & SECTION	NCSPRD3A.DGN
PLATE 26	26	DROP STR. 3 & RET. WALLS - ELEVATIONS	NCSPRD3B.DGN
PLATE 27	27	DROP STR. 3 RET. & CUT OFF WALLS - SECTIONS	NCSPRD3C.DGN
PLATE 28	28	DROP STR. 4 & BRIDGE PLAN, PROFILE, ELEV. & SECTIONS	NCSPRD4A.DGN
PLATE 29	29	DROP STR. 4 & RET. WALLS - ELEVATIONS	NCSPRD4B.DGN
PLATE 30	30	DROP STR. 4 RET. & CUT OFF WALLS - SECTIONS	NCSPRD4C.DGN
PLATE 31	31	OUTLETS D & E - SECTIONS	NCSPRPP1.DGN
PLATE 32	32	GATEWELL D - PLAN, SECTIONS & DETAILS	NCSPRO04.DGN
PLATE 33	33	GATEWELL E - PLAN, SECTIONS & DETAIL	NCSPRO03.DGN
PLATE 34	34	GATEWELL D OUTLET STR. - PLAN, PROFILE, ELEV. & DETAIL	NCSPR311.DGN
PLATE 35	35	STORM SEWER OUTLETS STA. 7+07 & 34+95 - PLAN, PROFILES & SECTIONS	NCSPROLT.DGN
		LANDSCAPE	
PLATE 36	36	LANDSCAPE DEVELOPEMENT - STA. 0+00 TO STA. 10+00	DPL1.DGN
PLATE 37	37	LANDSCAPE DEVELOPEMENT - STA. 10+00 TO STA. 20+00	DPL2.DGN
PLATE 38	38	LANDSCAPE DEVELOPEMENT - STA. 20+00 TO STA. 30+00	DPL3.DGN
PLATE 39	39	LANDSCAPE DEVELOPEMENT - STA. 30+00 TO STA. 40+00	DPL4.DGN
PLATE 40	40	LANDSCAPE DEVELOPEMENT - STA. 40+00 TO STA. 50+00	DPL5.DGN
PLATE 41	41	LANDSCAPE DEVELOPEMENT - STA. 50+00 TO STA. 61+93	DPL6.DGN
PLATE 42	42	LANDSCAPE DEVELOPEMENT - DETAILS	
PLATE 43	43	LANDSCAPE DEVELOPEMENT - DETAILS	

REFERENCE DRAWINGS

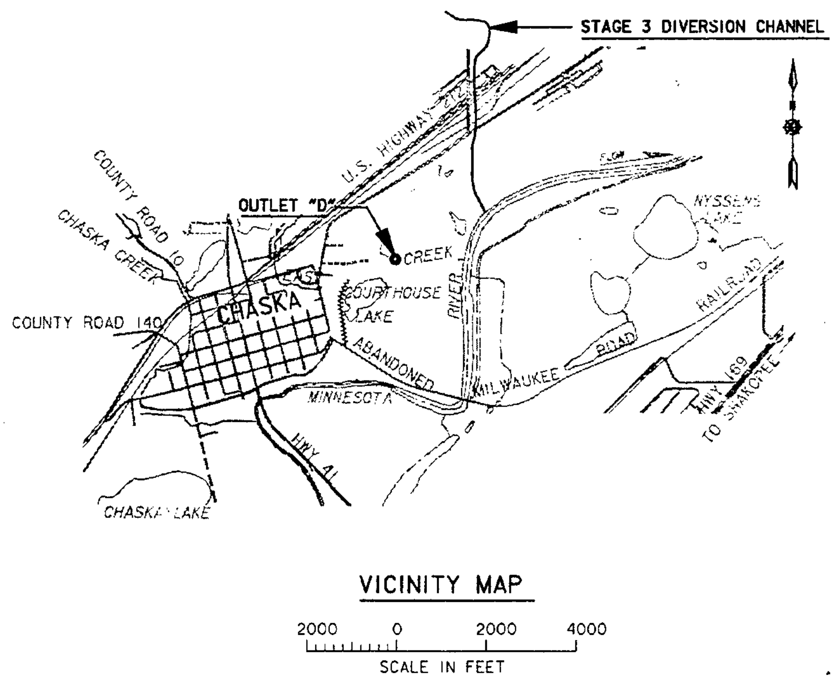
PLATE NO.	SHT.	DESCRIPTION
		GENERAL
PLATE D-1	1	BORING LOCATIONS NOT SHOWN ON PLAN & PROFILI
PLATE D-2	2	GEOLOGIC PROFILE - STA. 0+00 TO 61+50
PLATE D-3	3	BORING LOGS 80-30M & 80-32M THRU 80-33M
PLATE D-4	4	BORING LOGS 80-34M & 82-42M THRU 82-44M
PLATE D-5	5	BORING LOGS 82-45M , 82-46M & 88-98M
PLATE D-6	6	BORING LOGS 90-131M THRU 90-133M
PLATE D-7	7	BORING LOGS 90-134M THRU 90-136M
PLATE D-8	8	BORING LOGS 90-137M THRU 90-139M
PLATE D-9	9	BORING LOGS 90-140M, 90-141M & 90-143M
PLATE D-10	10	BORING LOGS 91-144M, 91-145A & 91-146M
PLATE D-11	11	BORING LOGS 91-147M, 91-148A 92-167M & 92-1
PLATE D-12	12	BORING LOGS 92-169M THRU 92-171M
PLATE D-13	13	BORING LOGS 92-172M THRU 92-174M
PLATE D-14	14	BORING LOGS 92-195M THRU 92-198M
PLATE D-15	15	BORING LOGS 92-199M THRU 92-202M
PLATE D-16	16	BORING LOGS 92-203M THRU 92-204M

NGS

	CAD FILE
PROFILE SHEETS	CHSPLAN.DGN
)	CHS33PR04.DGN
-33M	CHS3SH00.DGN
44M	CHS3SH01.DGN
	CHS3SH02.DGN
	CHS3SH03.DGN
	CHS3SH04.DGN
	CHS3SH05.DGN
143M	CHS3SH06.DGN
48M	CHS3SH07.DGN
& 92-168M	CHS3SH08.DGN
	CHS3SH09.DGN
	CHS3SH10.DGN
	CHS3SH11.DGN
	CHS3SH12.DGN
	CHS3SH13.DGN



LOCATION MAP



VICINITY MAP

SIGNATURES AFFIXED BELOW INDICATE OFFICIAL RECOMMENDATION AND APPROVAL OF ALL DRAWINGS IN THIS SET, AS INDEXED ON THIS SHEET.

APPROVAL RECOMMENDED BY:

PE — CHIEF, ED-D BRANCH

PE — CHIEF, ED-GH BRANCH

P.E. — CHIEF, ENGINEERING DIVISION

APPROVED BY:

COL., CORPS OF ENGINEERS

ENGINEER/MANAGER

CHIEF SPECS. & TECH. SUPPORT SECTION

CHIEF GENERAL ENGINEERING SECTION

CHIEF STRUCTURAL SECTION

CHIEF MECH/ELEC/ARCH SECTION

CHIEF HYDRAULICS SECTION

CHIEF HYDROLOGY SECTION

CHIEF GEOTECHNICAL DESIGN SECTION

	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

ED-D	DESIGNED:	MB
	CHECKED:	
	DRAWN:	T.J.
ED-GH	DESIGNED:	
	CHECKED:	
DATE:	12-10-93	

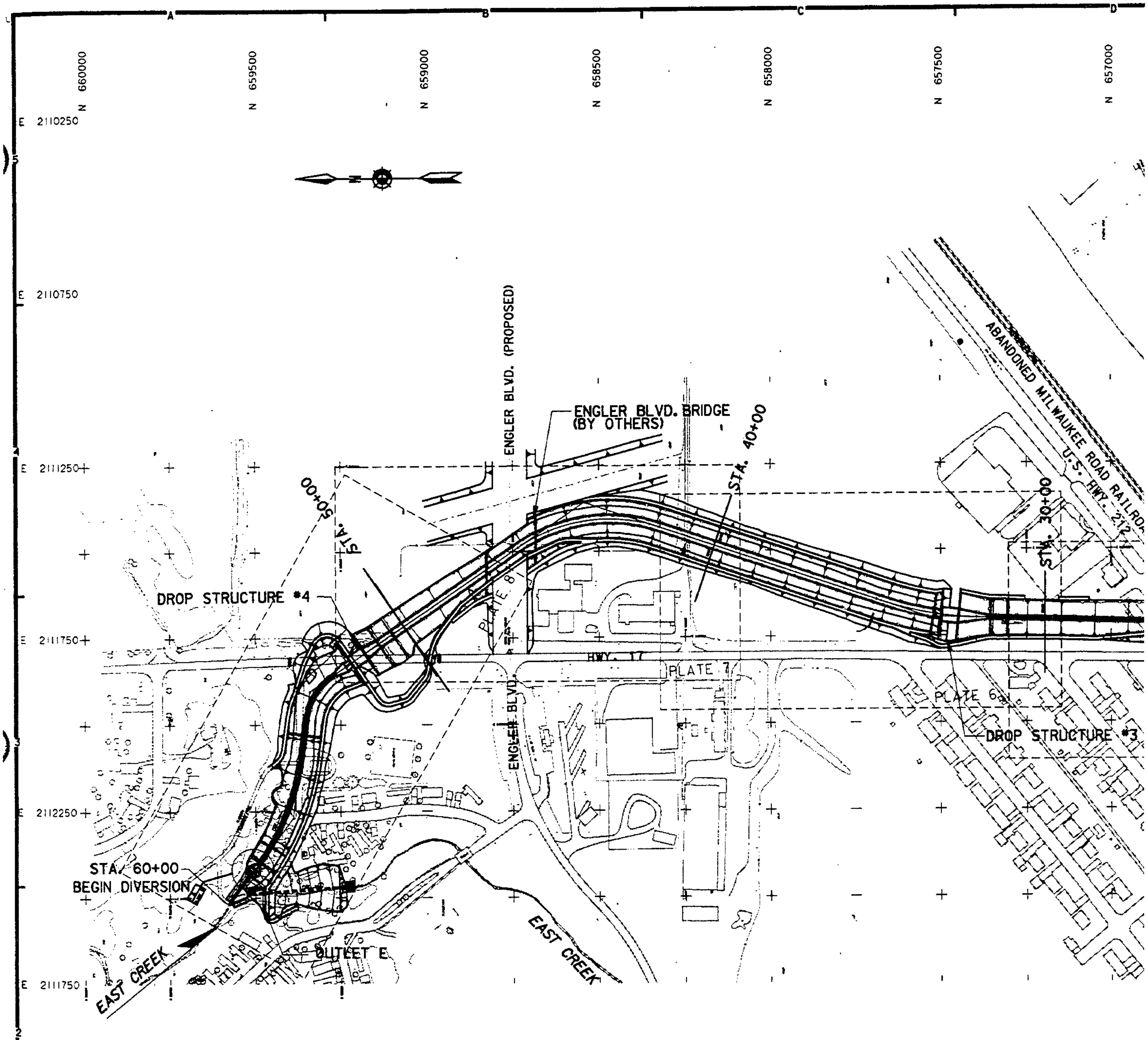
DESIGN MEMORANDUM
CHASKA STAGE 3
EAST CREEK

CHASKA PROJECT — CHASKA, MINNESOTA

FLOOD CONTROL
LOCATION MAP, VICINITY MAP AND DRAWING INDEX

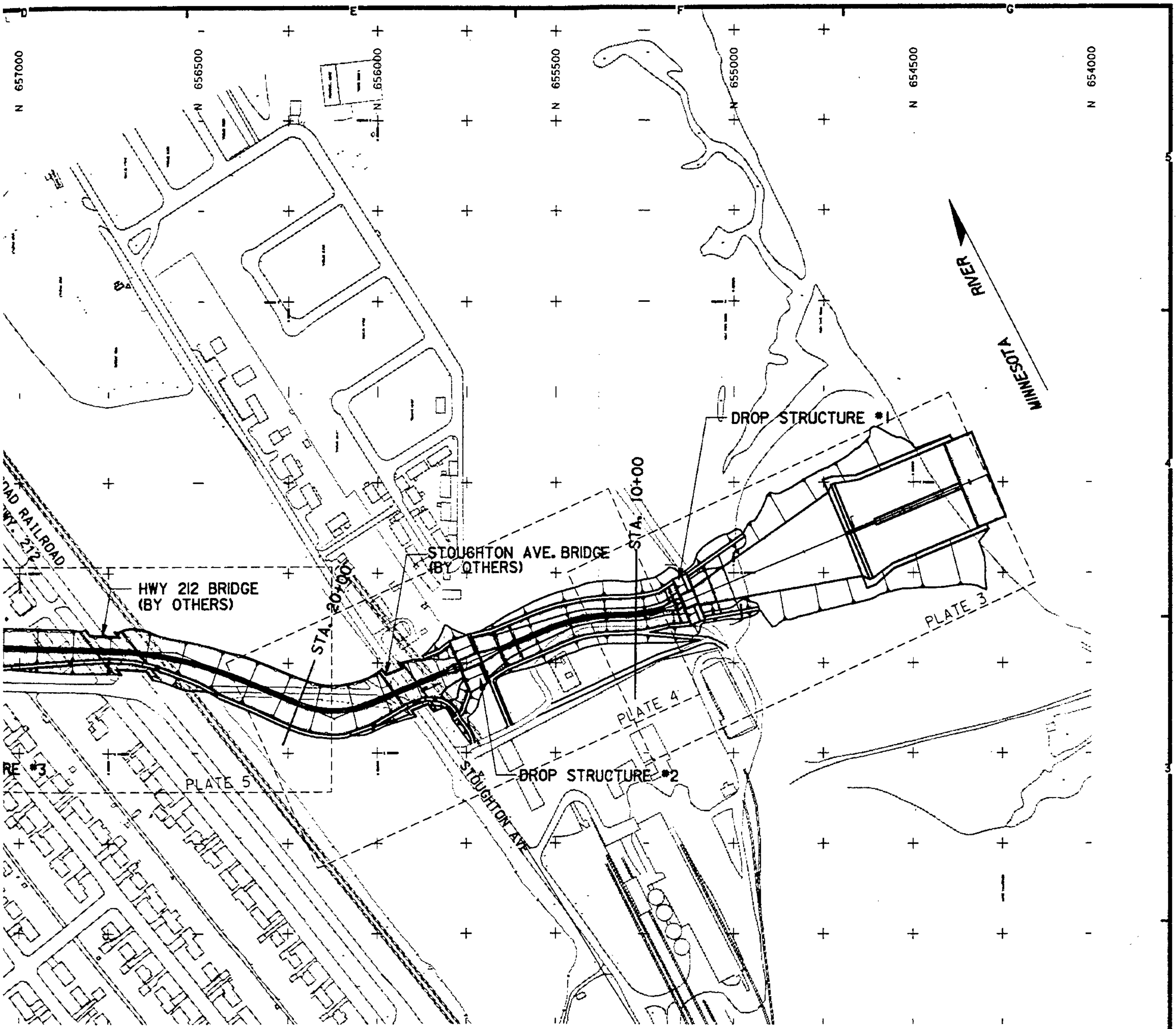
CAD FILE NAME: NC05P001.DGN
SPEC NO:
DRAWING NUMBER: PLATE 1
SHT 1 OF 43

(3)



GENERAL PLAN

200 0 200 400
SCALE IN FEET



NOTES:

1. THE COORDINATES SHOWN ARE REFERENCED TO NAD 27 AND ARE IN FEET BASED ON THE MINNESOTA STATE PLANE COORDINATE SYSTEM, SOUTH ZONE.

LEGEND

NEW RIPRAP
BORING LOCATION 80-34M
DENOTES CUT
DENOTES FILL
LIMITS OF WORK
LANDSCAPE OVERBUILD

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

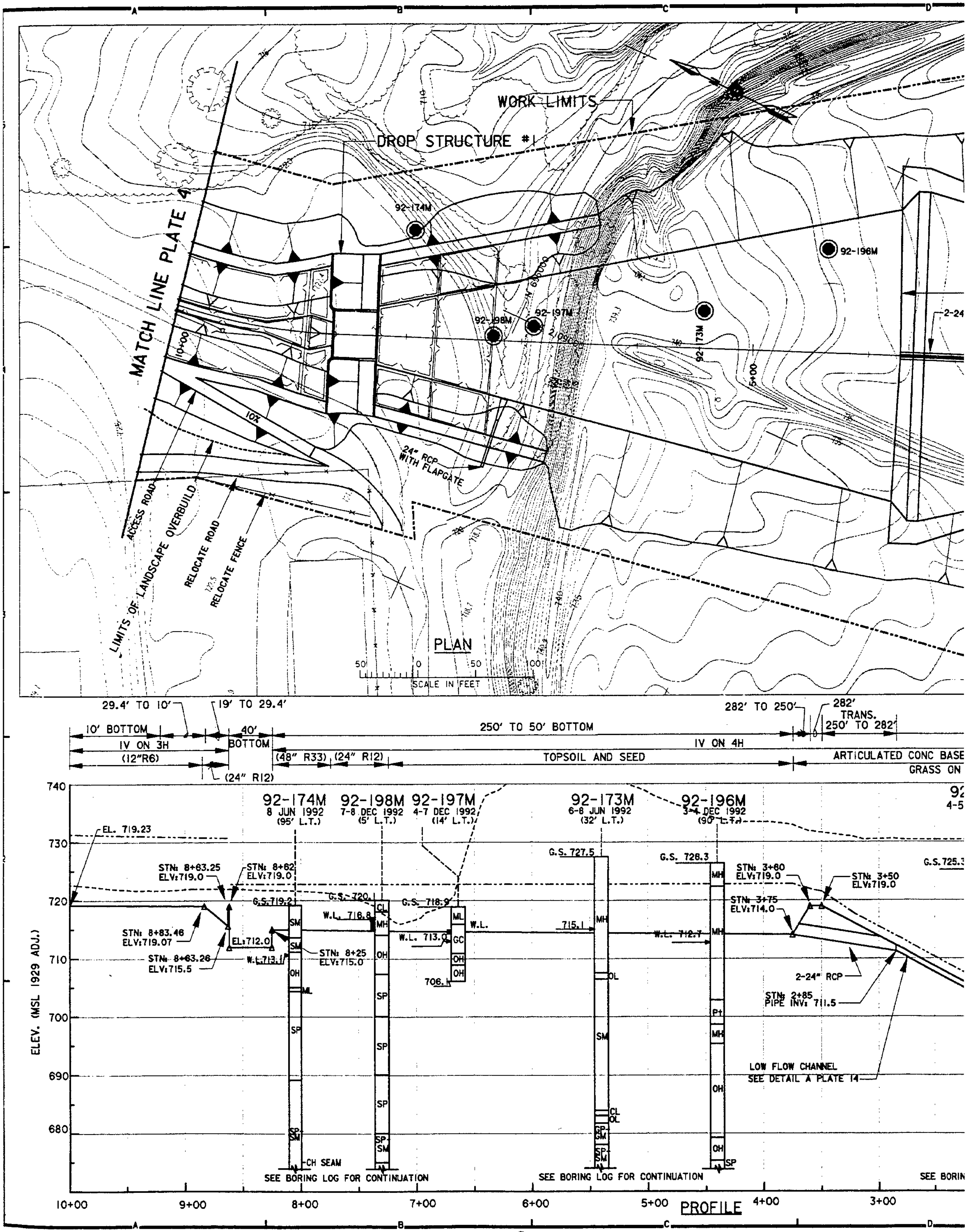
DESIGN MEMORANDUM
CHASKA - STAGE 3
EAST CREEK

CHASKA PROJECT — CHASKA, MINNESOTA
FLOOD CONTROL
GENERAL PLAN

ED-D	DESIGNED:	MB
	CHECKED:	CA
	DRAWN:	TJ
ED-GH	DESIGNED:	
	CHECKED:	
DATE:		12-10-93

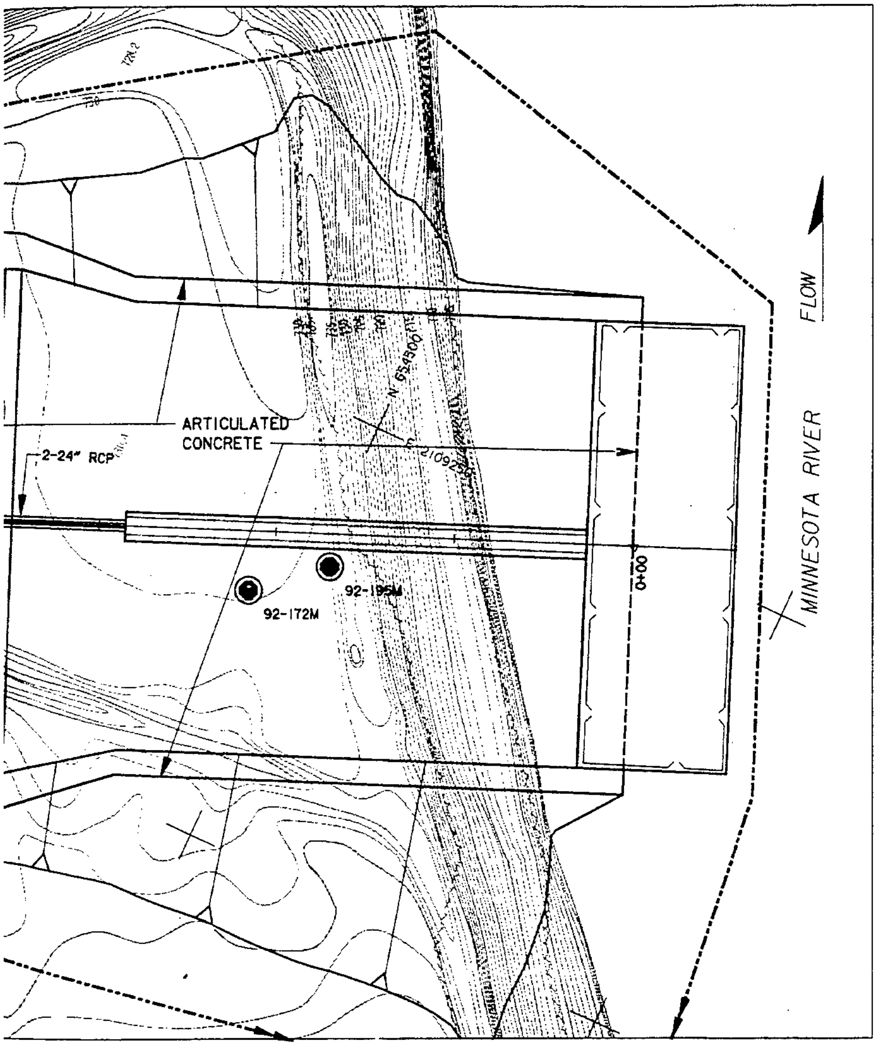
CAD FILE NAME: NC05P002.DGN
SPEC NO: DACW37-90-B-0000
DRAWING NUMBER: PLATE 2
SHT 2 OF 43

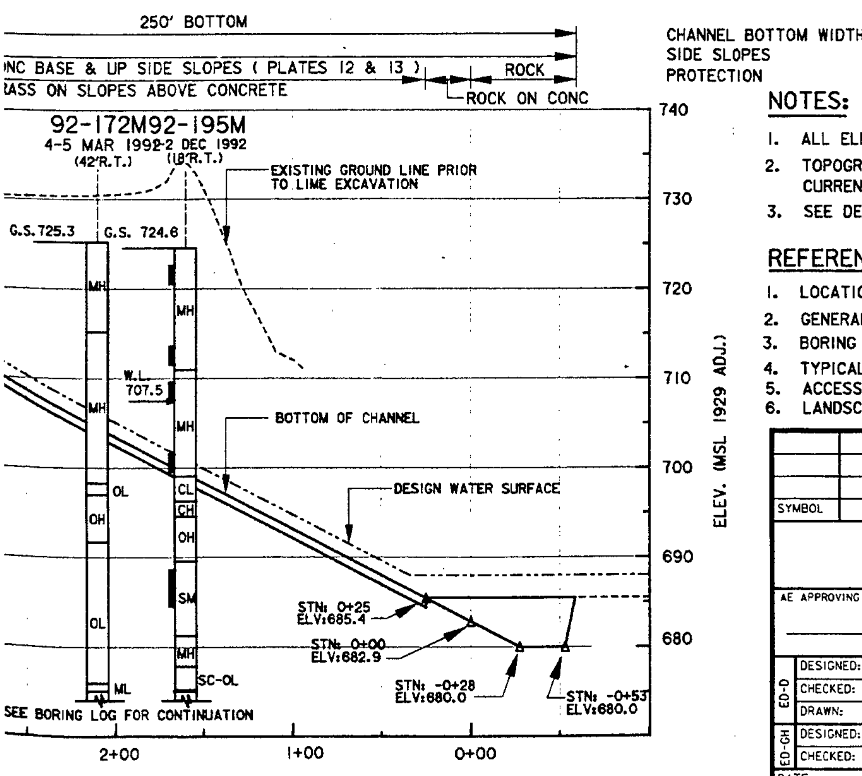
(2)



WORK LIMITS
DROP STRUCTURE #1
MATCH LINE PLATE 4
92-174M
92-198M
92-197M
92-173M
92-196M
24" RCP WITH FLAPGATE
10%
10+00
5+00
ACCESS ROAD
LIMITS OF LANDSCAPE OVERBUILD
RELOCATE ROAD
RELOCATE FENCE
PLAN
SCALE IN FEET
29.4' TO 10'
19' TO 29.4'
10' BOTTOM
40' BOTTOM
IV ON 3H
(12"R6)
(24" R12)
(48" R33)
250' TO 50' BOTTOM
TOPSOIL AND SEED
IV ON 4H
282' TO 250'
282' TRANS.
250' TO 282'
ARTICULATED CONC BASE
GRASS ON
92-174M 8 JUN 1992 (95' L.T.)
92-198M 7-8 DEC 1992 (5' L.T.)
92-197M 4-7 DEC 1992 (14' L.T.)
92-173M 6-8 JUN 1992 (32' L.T.)
92-196M 3-4 DEC 1992 (90' L.T.)
EL. 719.23
STN: 8+63.25 ELV:719.0
STN: 8+62 ELV:719.0
STN: 8+83.46 ELV:719.07
STN: 8+63.26 ELV:715.5
EL:712.0
W.L. 713.1
STN: 8+25 ELV:715.0
G.S. 719.2
G.S. 720
W.L. 716.8
G.S. 718.9
W.L. 713.0
W.L.
706.1
G.S. 727.5
715.1
G.S. 728.3
W.L. 712.7
STN: 3+60 ELV:719.0
STN: 3+50 ELV:719.0
STN: 3+75 ELV:714.0
G.S. 725.3
2-24" RCP
STN: 2+85 PIPE INV: 711.5
LOW FLOW CHANNEL SEE DETAIL A PLATE 14
CH SEAM
SEE BORING LOG FOR CONTINUATION
ELEV. (MSL 1929 ADJ.)
740
730
720
710
700
690
680
10+00
9+00
8+00
7+00
6+00
5+00
4+00
3+00
PROFILE

10





LEVEE ELEVATIONS

STATION	LEFT LEVEE ELEV. (LOOKING D/S)	RIGHT LEVEE ELEV. (LOOKING D/S)
6+39	723.8'	-
6+75	723.8'	723.8'
8+25	723.8'	723.8'
8+62	732.2'	732.2'
11+60	733.2'	733.2'

LEVEE OVERBUILD

OVERBUILD HEIGHT	LEFT BANK STATION RANGE	RIGHT BANK STATION RANGE
2'	6+35 TO 8+25	6+65 TO 8+25
1'	8+62 TO 11+10	8+62 TO 11+10

NOTES:

1. ALL ELEVATIONS SHOWN ARE MSL 1929 ADJ.
2. TOPOGRAPHY FROM STATION 0+60 TO STATION 6+50 DOES NOT REFLECT CURRENT GROUND SURFACE.
3. SEE DETAIL PLATE 13 FOR LEVEE OVERBUILD

REFERENCES:

REFERENCES	PLATE NO.
1. LOCATION MAP, VICINITY MAP, & DRAWING INDEX	1
2. GENERAL PLAN	2
3. BORING LOGS	D1-D16
4. TYPICAL SECTIONS	12 - 14
5. ACCESS ROAD	19
6. LANDSCAPE PLAN	36

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

DESIGN MEMORANDUM
CHASKA - STAGE 3
EAST CREEK

CHASKA PROJECT CHASKA, MINNESOTA

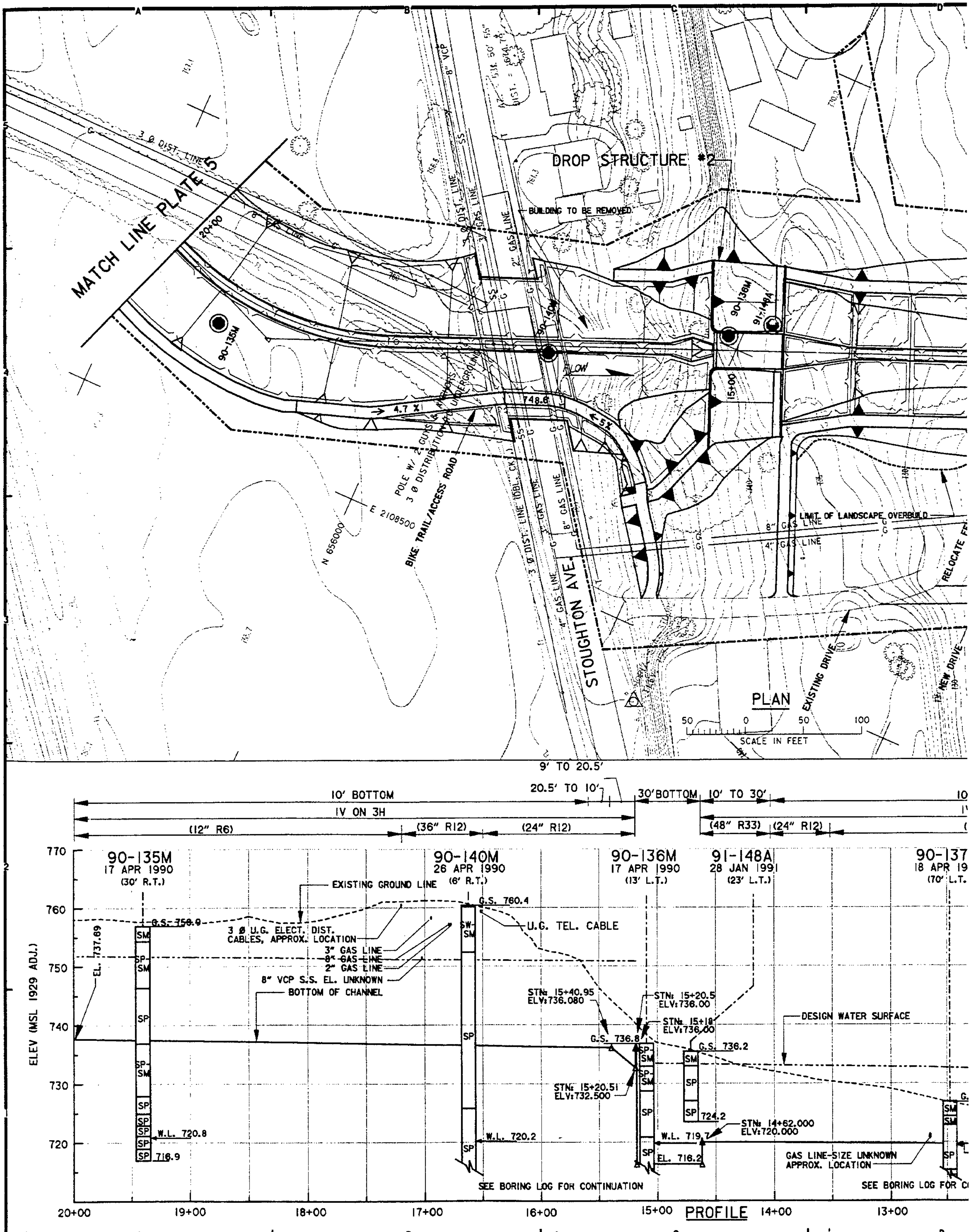
FLOOD CONTROL

PLAN & PROFILE
STA. 0+00 TO 10+00

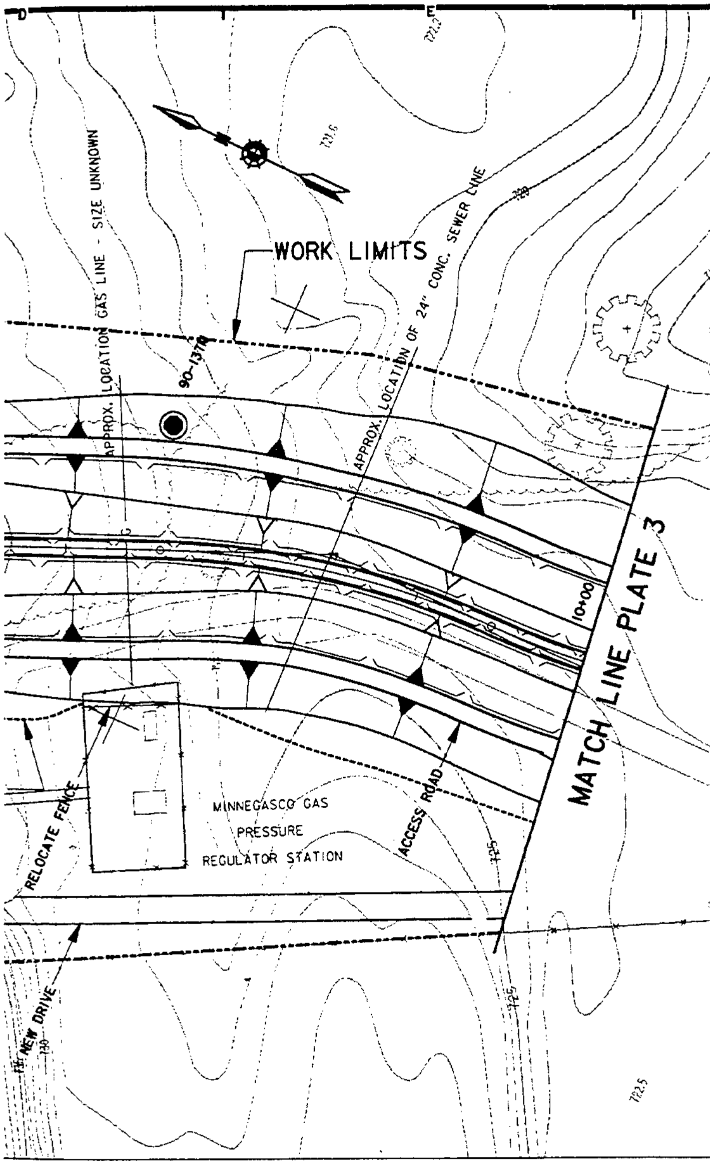
ED-D	DESIGNED:	MB
	CHECKED:	CCL
	DRAWN:	T.J.
ED-GH	DESIGNED:	
	CHECKED:	
DATE:		12-10-93

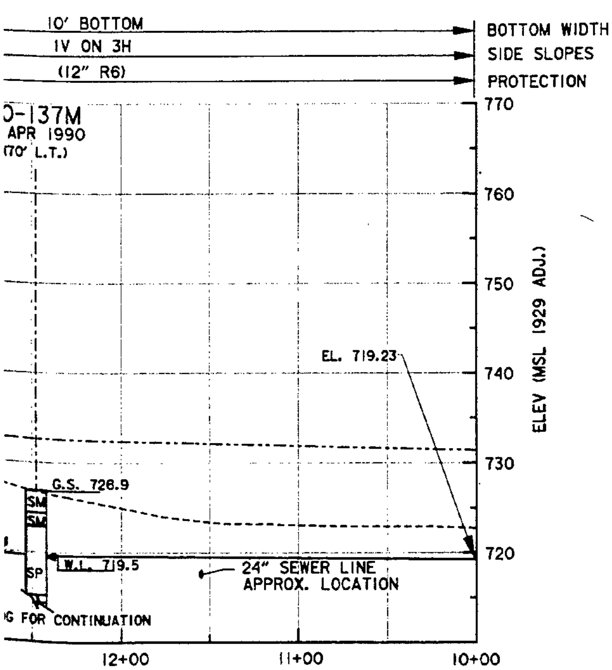
CAD FILE NAME: NC05P003.DGN
SPEC NO:
DRAWING NUMBER: PLATE 3
SHT 3 OF 43

(2)



MATCH LINE PLATE 5
3 Ø DIST. LINE
DROP STRUCTURE #2
BUILDING TO BE REMOVED
8" VCP
SS
3 Ø DIST. LINE
3" GAS LINE
2" GAS LINE
20+00
90-135M
90-140M
90-136M
91-148A
15+00
FLOW
4.7 X1
748.6
5X
POLE W/ 2 GUYS & ANCHORS
3 Ø DISTRIBUTION TO UNDERGROUND
BIKE TRAIL/ACCESS ROAD
E 2108500
N 656000
3 Ø DIST. LINE (DBL. CK.)
3" GAS LINE
8" GAS LINE
4" GAS LINE
STOUGHTON AVE.
LIMIT OF LANDSCAPE OVERBUILD
8" GAS LINE
4" GAS LINE
RELOCATE
EXISTING DRIVE
NEW DRIVE
PLAN
50 0 50 100
SCALE IN FEET
9' TO 20.5'
20.5' TO 10'
10' BOTTOM
30' BOTTOM
10' TO 30'
IV ON 3H
(12" R6)
(36" R12)
(24" R12)
(48" R33)
(24" R12)
90-135M
17 APR 1990
(30' R.T.)
90-140M
26 APR 1990
(6' R.T.)
90-136M
17 APR 1990
(13' L.T.)
91-148A
28 JAN 1991
(23' L.T.)
90-137
18 APR 19
(70' L.T.
EXISTING GROUND LINE
G.S. 758.9
G.S. 760.4
U.G. TEL. CABLE
3 Ø U.G. ELECT. DIST. CABLES, APPROX. LOCATION
3" GAS LINE
8" GAS LINE
2" GAS LINE
8" VCP S.S. EL. UNKNOWN
BOTTOM OF CHANNEL
EL. 737.89
STN: 15+40.95
ELV: 736.080
STN: 15+20.5
ELV: 736.00
STN: 15+18
ELV: 736.00
DESIGN WATER SURFACE
G.S. 736.8
G.S. 736.2
STN: 15+20.51
ELV: 732.500
W.L. 720.8
716.9
W.L. 720.2
W.L. 719.7
EL. 716.2
724.2
STN: 14+62.000
ELV: 720.000
GAS LINE-SIZE UNKNOWN APPROX. LOCATION
SEE BORING LOG FOR CONTINUATION
SEE BORING LOG FOR C
SM
SP
SW
ELEV (MSL 1929 ADJ.)
770
760
750
740
730
720
20+00
19+00
18+00
17+00
16+00
15+00
14+00
13+00
PROFILE





LEVEE ELEVATIONS		
STATION	LEFT LEVEE ELEV. (LOOKING D/S)	RIGHT LEVEE ELEV. (LOOKING D/S)
8+62	732.2'	732.2'
11+60	733.2'	733.2'
12+60	735.2'	735.2'
14+62	735.8'	735.8'
15+18	753.4'	753.4'
16+08	753.5'	753.5'

LEVEE OVERBUILD		
OVERBUILD HEIGHT	LEFT LEVEE STATION RANGE	RIGHT LEVEE STATION RANGE
1'	8+62 TO 11+10	8+62 TO 11+10

NOTES:

1. ALL ELEVATIONS SHOWN ARE MSL 1929 ADJ.
2. SEE DETAIL PLATE 13 FOR LEVEE OVERBUILD

REFERENCES:	PLATE NO.
1. LOCATION MAP, VICINITY MAP, & DRAWING INDEX	1
2. GENERAL PLAN	2
3. BORING LOGS	D1-D16
4. TYPICAL SECTIONS	15
5. BIKE PATH DETAILS	19
6. ACCESS ROAD	19
7. LANDSCAPE PLAN	37

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

DESIGN MEMORANDUM
CHASKA - STAGE 3
EAST CREEK

CHASKA PROJECT — CHASKA, MINNESOTA

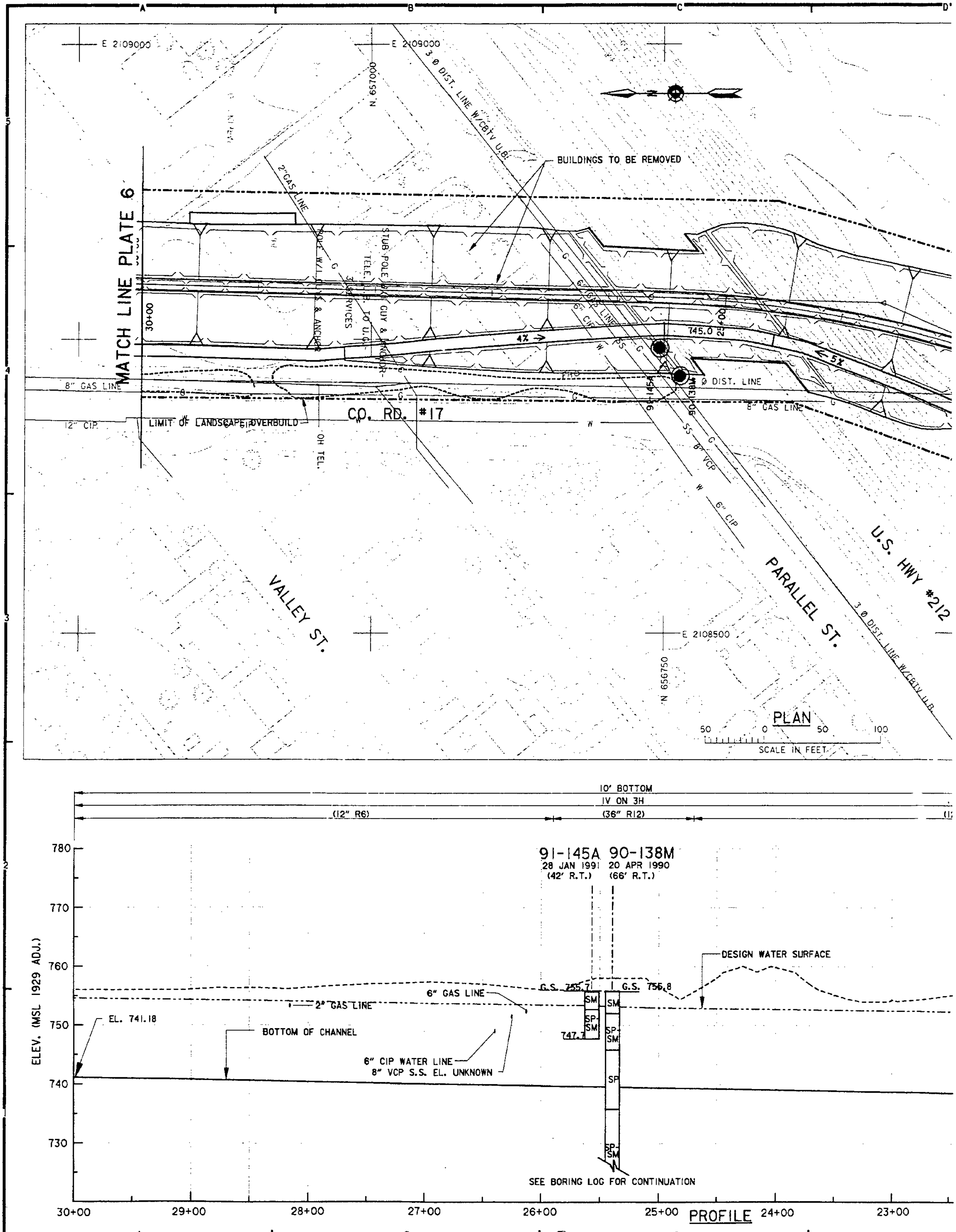
FLOOD CONTROL

PLAN & PROFILE
STA. 10+00 TO 20+00

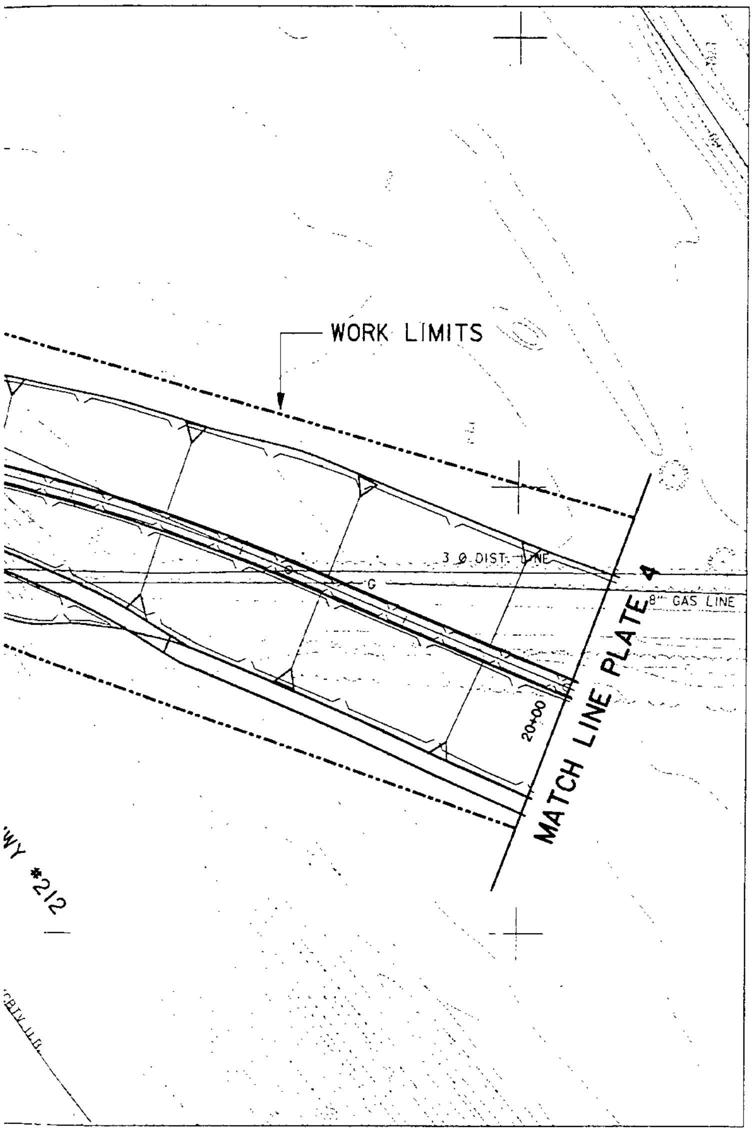
ED-D	DESIGNED:	MB
ED-D	CHECKED:	CR
ED-D	DRAWN:	T.J.
ED-GH	DESIGNED:	
ED-GH	CHECKED:	
	DATE:	12-10-93

CAD FILE NAME: NC05P004.DGN
SPEC NO:
DRAWING NUMBER: PLATE 4
SHT 4 OF 43

2



E 2109000
E 2109000
N 657000
3 Ø DIST. LINE W/CBTV U.G.
BUILDINGS TO BE REMOVED
2" GAS LINE
MATCH LINE PLATE 6
30+00
STUB POLE W/ GUY & ANCHOR
TELE. TO U.G.
3 SERVICES
POLE W/ GUY & ANCHOR
6" GAS LINE
6" CIP
4% →
745.0
25+00
← 5%
8" GAS LINE
12" CIP
Ø DIST. LINE
8" GAS LINE
LIMIT OF LANDSCAPE OVERBUILD
CO. RD. #17
OH TEL.
SS 8" VCP
W 6" CIP
91-145A
90-138M
U.S. HWY #212
PARALLEL ST.
VALLEY ST.
3 Ø DIST. LINE W/CBTV U.G.
E 2108500
N 656750
PLAN
50 0 50 100
SCALE IN FEET
10' BOTTOM
1V ON 3H
(12" R6)
(36" R12)
91-145A
28 JAN 1991
(42' R.T.)
90-138M
20 APR 1990
(66' R.T.)
780
770
760
750
740
730
ELEV. (MSL 1929 ADJ.)
DESIGN WATER SURFACE
G.S. 755.7
G.S. 755.8
6" GAS LINE
2" GAS LINE
EL. 741.18
BOTTOM OF CHANNEL
6" CIP WATER LINE
8" VCP S.S. EL. UNKNOWN
747.7
SM
SP-SM
SP
SEE BORING LOG FOR CONTINUATION
30+00
29+00
28+00
27+00
26+00
25+00
24+00
23+00
PROFILE

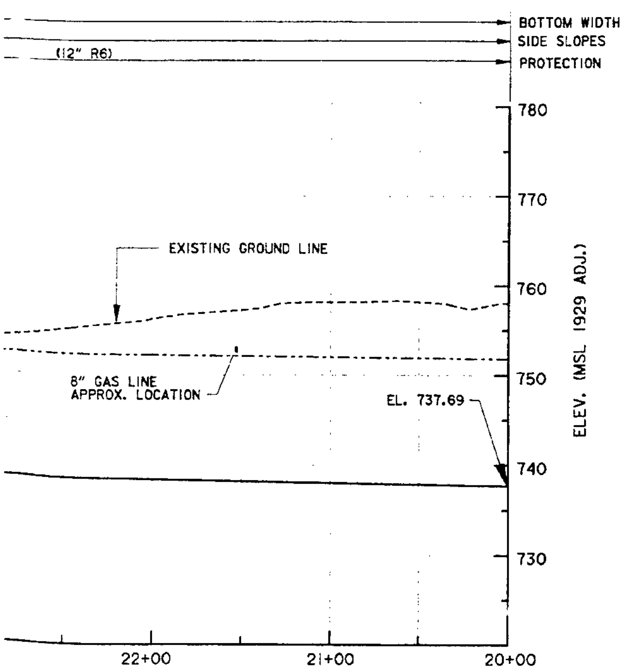


LEVEE ELEVATIONS		
STATION	LEFT LEVEE ELEV. (LOOKING D/S)	RIGHT LEVEE ELEV. (LOOKING D/S)
28+70	756.8'	-
29+60	757.0'	-

NOTES:

1. ALL ELEVATIONS SHOWN ARE MSL 1929 ADJ.

REFERENCES:	PLATE NO.
1. LOCATION MAP, VICINITY MAP, & DRAWING INDEX	1
2. GENERAL PLAN	2
3. BORING LOGS	D1-D16
4. TYPICAL SECTIONS	15
5. BIKE PATH DETAILS	19
6. LANDSCAPE PLAN	38



SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

DESIGN MEMORANDUM
CHASKA - STAGE 3
EAST CREEK

CHASKA PROJECT — CHASKA, MINNESOTA

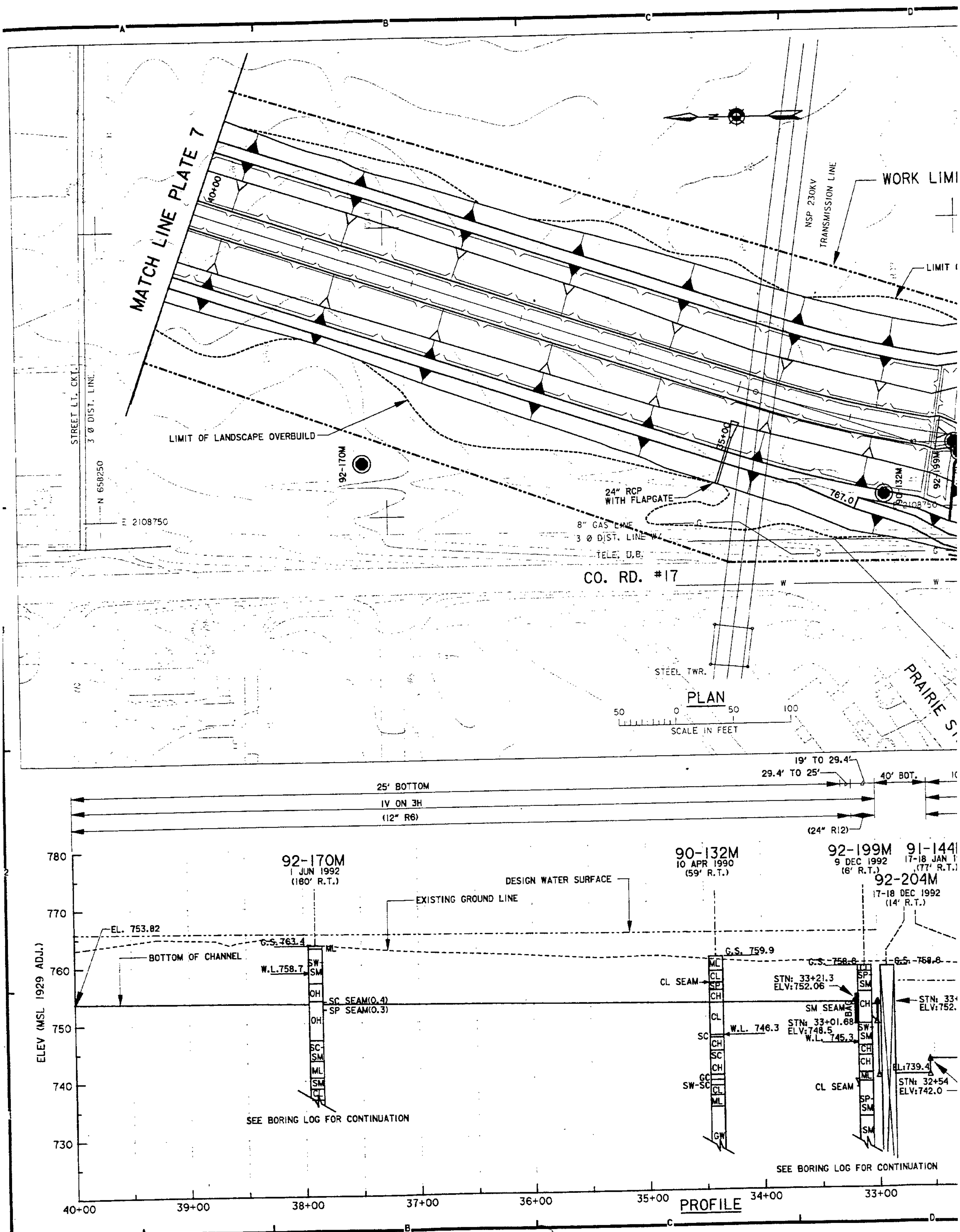
FLOOD CONTROL

PLAN & PROFILE
STA. 20+00 TO 30+00

ED-D	DESIGNED:	MB
ED-D	CHECKED:	CA
ED-D	DRAWN:	T.J.
ED-GH	DESIGNED:	
ED-GH	CHECKED:	
	DATE:	12-10-93

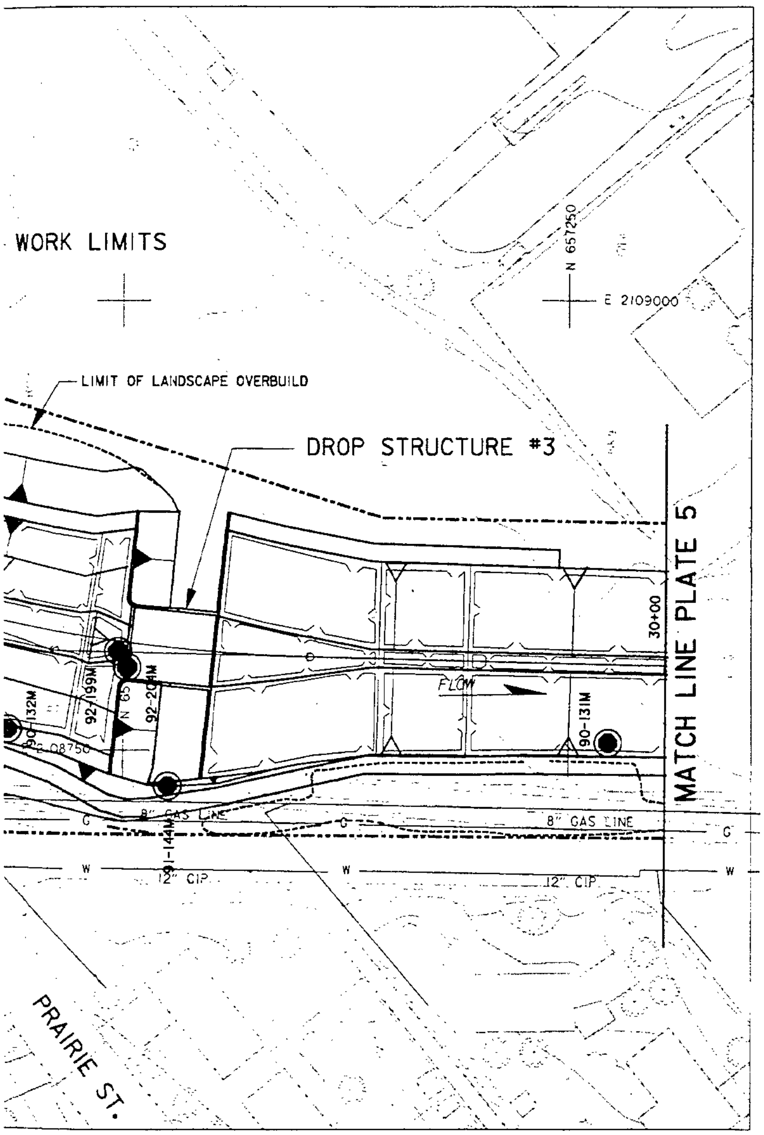
CAD FILE NAME: NC05P005.DGN
SPEC NO:
DRAWING NUMBER: PLATE 5
SHT 5 OF 43

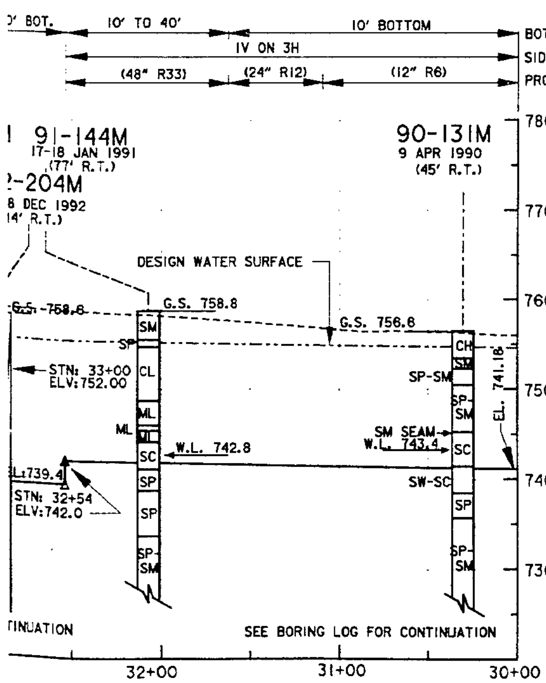
9



MATCH LINE PLATE 7
40+00
35+00
WORK LIMI
LIMIT
NSP 230KV TRANSMISSION LINE
STREET LT. CKT.
3 Ø DIST. LINE
N 658250
E 2108750
LIMIT OF LANDSCAPE OVERBUILD
92-170M
24" RCP WITH FLAPGATE
8" GAS LINE
3 Ø DIST. LINE W/
TELE. U.B.
CO. RD. #17
90-132M
92-199M
767.0
STEEL TWR.
PRAIRIE S
PLAN
50 0 50 100
SCALE IN FEET
19' TO 29.4'
29.4' TO 25'
40' BOT.
25' BOTTOM
1V ON 3H
(12" R6)
(24" R12)
92-170M
1 JUN 1992
(160' R.T.)
90-132M
10 APR 1990
(59' R.T.)
92-199M
9 DEC 1992
(6' R.T.)
91-144
17-18 JAN
(77' R.T.)
92-204M
17-18 DEC 1992
(14' R.T.)
DESIGN WATER SURFACE
EXISTING GROUND LINE
EL. 753.82
BOTTOM OF CHANNEL
G.S. 763.4
W.L. 758.7
SC SEAM(0.4)
SP SEAM(0.3)
G.S. 759.9
CL SEAM
W.L. 746.3
G.S. 758.8
STN: 33+21.3
ELV: 752.06
SM SEAM
STN: 33+01.68
ELV: 748.5
W.L. 745.3
EL. 739.4
STN: 32+54
ELV: 742.0
CL SEAM
SEE BORING LOG FOR CONTINUATION
ELEV (MSL 1929 ADJ.)
780
770
760
750
740
730
40+00
39+00
38+00
37+00
36+00
35+00
34+00
33+00
PROFILE

1





LEVEE ELEVATIONS

STATION	LEFT LEVEE ELEV. (LOOKING D/S)	RIGHT LEVEE ELEV. (LOOKING D/S)
30+60	757.4'	-
32+54	758.2'	-
33+01	766.8'	766.8'
48+70	770.9'	770.9'

LEVEE OVERBUILD

OVERBUILD HEIGHT	LEFT LEVEE STATION RANGE	RIGHT LEVEE STATION RANGE
0.25'	33+21 TO 44+00	33+21 TO 46+00

NOTES:

1. ALL ELEVATIONS SHOWN ARE MSL 1929 ADJ.
2. SEE DETAIL PLATE 13 FOR LEVEE OVERBUILD

REFERENCES:	PLATE NO.
1. LOCATION MAP, VICINITY MAP, & DRAWING INDEX	1
2. GENERAL PLAN	2
3. BORING LOGS	D1-D16
4. TYPICAL SECTIONS	16
5. BIKE TRAIL DETAILS	19
6. 24" RCP STORM SEWER DETAIL	35
7. LANDSCAPE PLAN	39

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

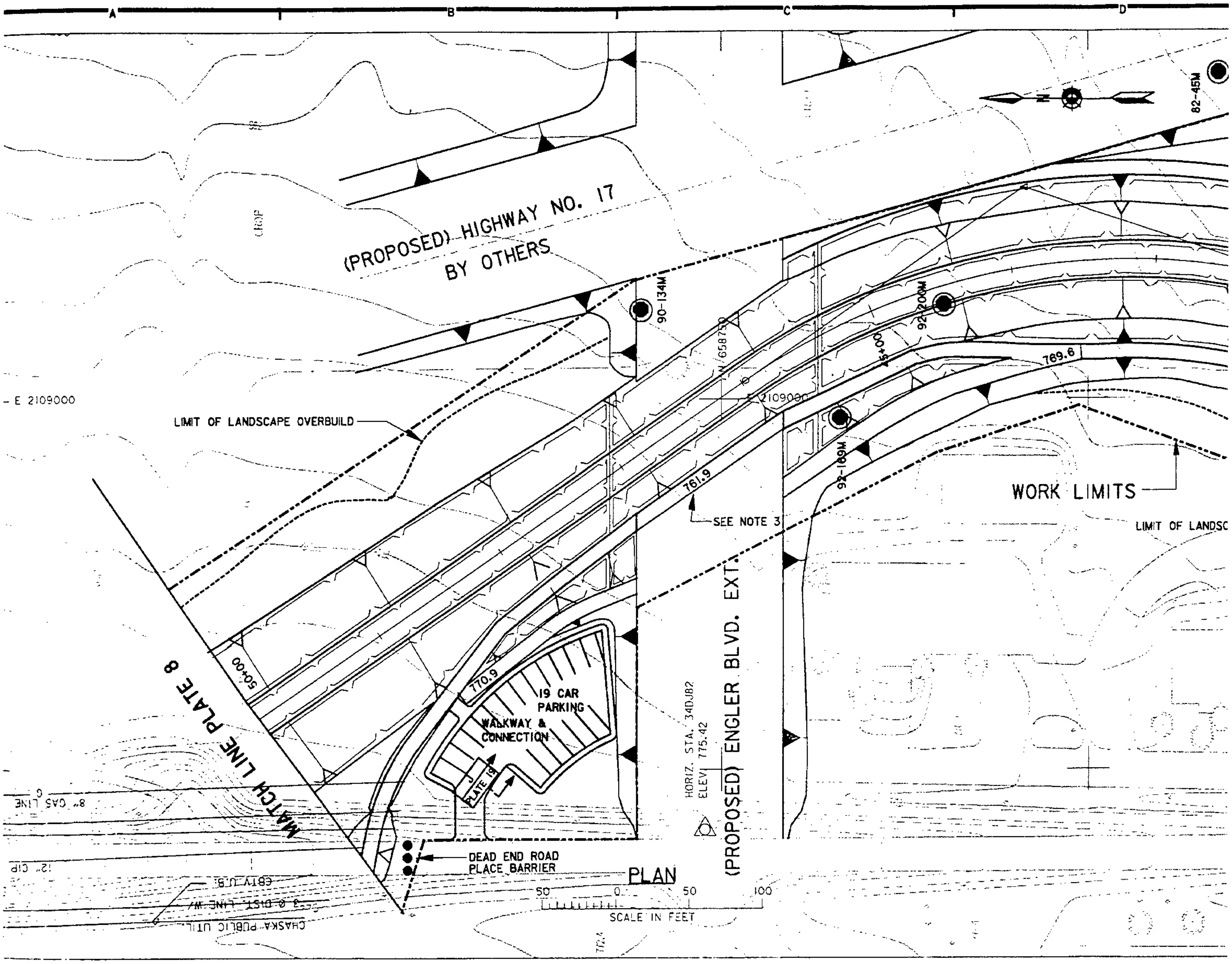
DESIGN MEMORANDUM
CHASKA - STAGE 3
EAST CREEK

CHASKA PROJECT — CHASKA, MINNESOTA

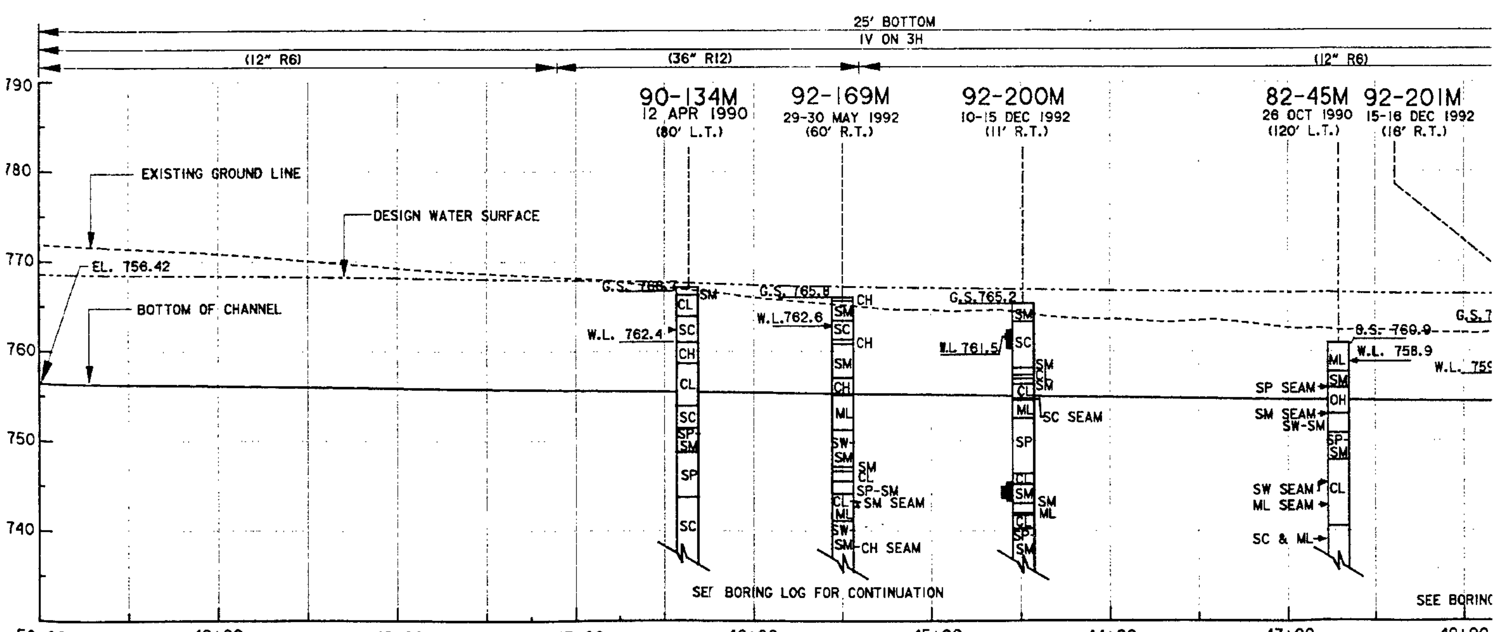
FLOOD CONTROL
PLAN & PROFILE
STA. 30+00 TO 40+00

ED-D DESIGNED:	MB
ED-D CHECKED:	CK
ED-D DRAWN:	T.J.
ED-GH DESIGNED:	
ED-GH CHECKED:	
DATE:	12-10-93

CAD FILE NAME: NC05P006.DGN
SPEC NO: DACW37-91-B-XXXX
DRAWING NUMBER: PLATE 6
SHT 6 OF 43

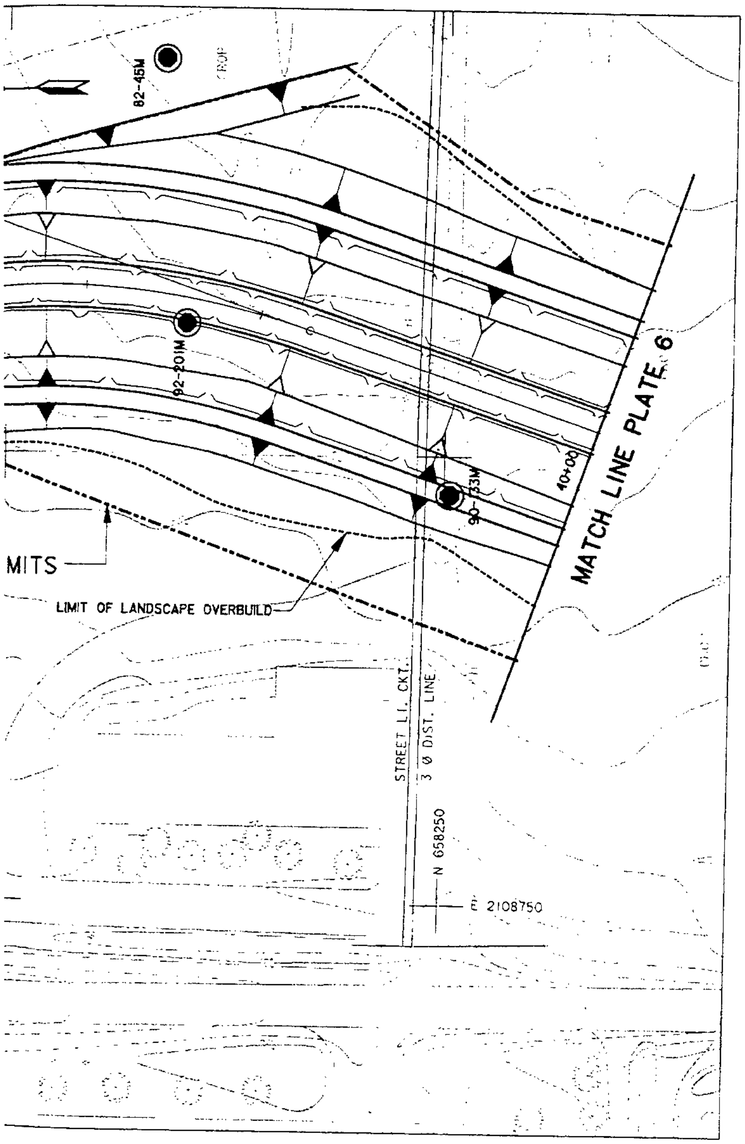


PLAN



PROFILE

1



LEVEE ELEVATIONS		
STATION	LEFT LEVEE ELEV. (LOOKING D/S)	RIGHT LEVEE ELEV. (LOOKING D/S)
33+01	766.8'	766.8'
45+80	770.1'	770.1'
48+70	-	770.9'

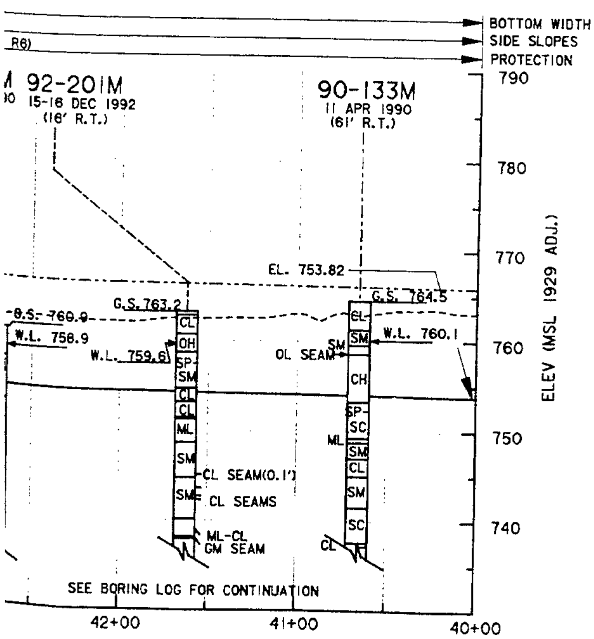
LEVEE OVERBUILD		
OVERBUILD HEIGHT	LEFT LEVEE STATION RANGE	RIGHT LEVEE STATION RANGE
0.25'	33+21 TO 44+00	33+21 TO 46+00

NOTES:

1. ALL ELEVATIONS SHOWN ARE MSL 1929 ADJ.
2. SEE DETAIL PLATE 13 FOR LEVEE OVERBUILD
3. FINAL BIKE TRAIL ALIGNMENT AND ELEVATION BASED ON FINAL ENGLER BRIDGE DESIGN PROVIDED BY OTHERS

REFERENCES:

		PLATE NO.
1.	LOCATION MAP, VICINITY MAP, & DRAWING INDEX	1
2.	GENERAL PLAN	2
3.	BORING LOGS	D1-D16
4.	TYPICAL SECTIONS	16
5.	BIKE TRAIL DETAILS	19
6.	STORM SEWER DETAILS	35
7.	LANDSCAPE PLAN	40



SYMBOL	DESCRIPTION	DATE	APPROVAL

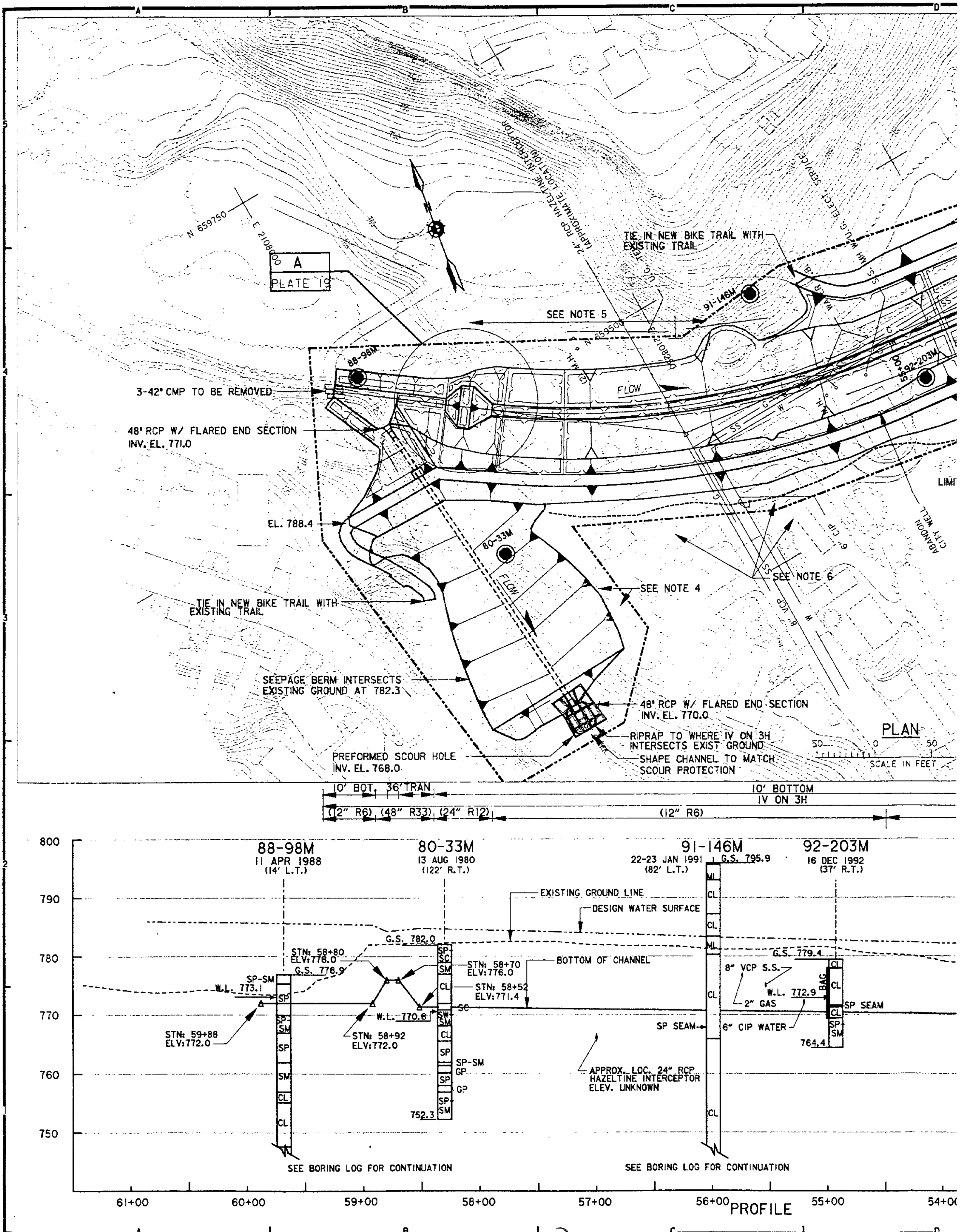
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

DESIGN MEMORANDUM
CHASKA - STAGE 3
EAST CREEK
CHASKA PROJECT CHASKA, MINNESOTA
FLOOD CONTROL
PLAN & PROFILE
STA. 40+00 TO 50+00

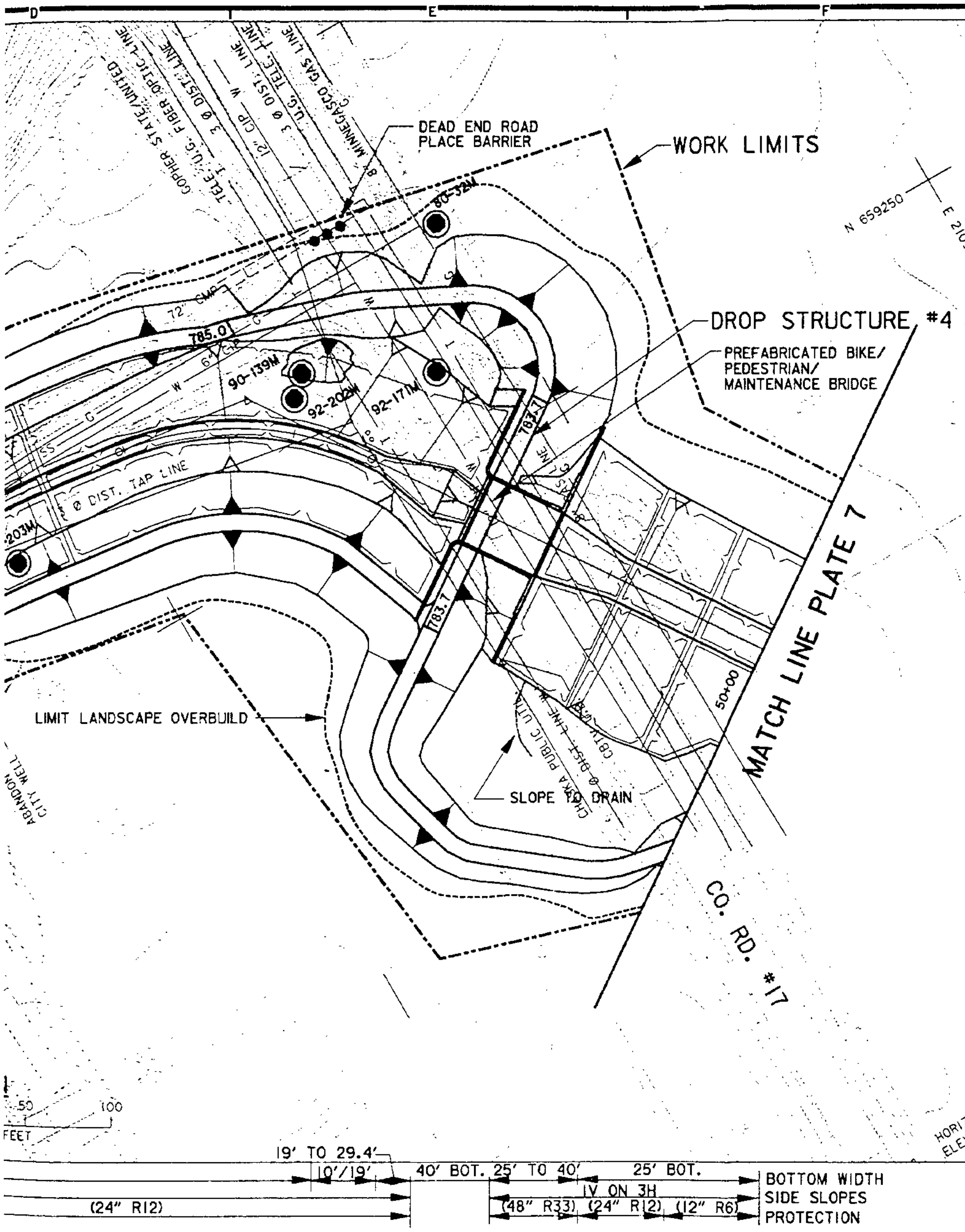
DESIGNED: MB
CHECKED: CCC
DRAWN: T.J.
DESIGNED:
CHECKED:
DATE: 12-10-93
CAD FILE NAME: NC05P007.DGN
SPEC NO:
DRAWING NUMBER: PLATE 7
SHT 7 OF 43

(7)



A
PLATE 19
N 659750
E 2108000
24" RCP HAZELTINE INTERCEPTOR (APPROXIMATE LOCATION)
TIE IN NEW BIKE TRAIL WITH EXISTING TRAIL
SEE NOTE 5
91-146M
88-98M
92-203M
3-42" CMP TO BE REMOVED
48" RCP W/ FLARED END SECTION INV. EL. 771.0
FLOW
EL. 788.4
80-33M
SEE NOTE 6
SEE NOTE 4
TIE IN NEW BIKE TRAIL WITH EXISTING TRAIL
SEEPAGE BERM INTERSECTS EXISTING GROUND AT 782.3
48" RCP W/ FLARED END SECTION INV. EL. 770.0
RIPRAP TO WHERE IV ON 3H INTERSECTS EXIST GROUND
SHAPE CHANNEL TO MATCH SCOUR PROTECTION
PREFORMED SCOUR HOLE INV. EL. 768.0
ABANDON CITY WELL
PLAN
SCALE IN FEET
10' BOT. 36' TRAN
10' BOTTOM
IV ON 3H
(12" R6) (48" R33) (24" R12)
(12" R6)
88-98M
11 APR 1988
(14' L.T.)
80-33M
13 AUG 1980
(122' R.T.)
91-146M
22-23 JAN 1991
(82' L.T.)
G.S. 795.9
92-203M
16 DEC 1992
(37' R.T.)
EXISTING GROUND LINE
DESIGN WATER SURFACE
G.S. 782.0
STN: 58+80 ELV: 776.0
G.S. 776.9
STN: 58+70 ELV: 776.0
BOTTOM OF CHANNEL
STN: 58+52 ELV: 771.4
W.L. 773.1
W.L. 770.6
STN: 59+88 ELV: 772.0
STN: 58+92 ELV: 772.0
G.S. 779.4
8" VCP S.S.
2" GAS
W.L. 772.9
SP SEAM
6" CIP WATER
764.4
752.3
APPROX. LOC. 24" RCP HAZELTINE INTERCEPTOR ELEV. UNKNOWN
SEE BORING LOG FOR CONTINUATION
SEE BORING LOG FOR CONTINUATION
800
790
780
770
760
750
61+00
60+00
59+00
58+00
57+00
56+00
55+00
54+00
PROFILE

(7)



LEVEE ELEVATIONS

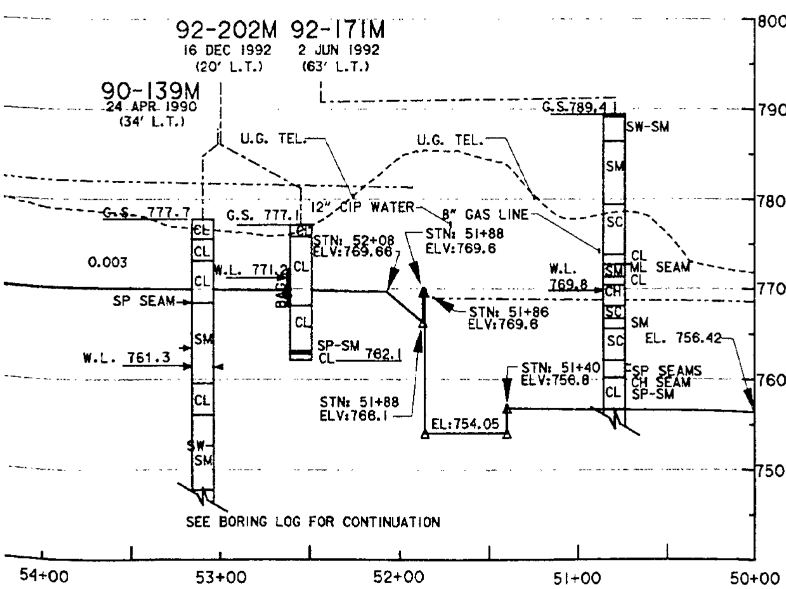
STATION	LEFT LEVEE ELEV. (LOOKING D/S)	RIGHT LEVEE ELEV. (LOOKING D/S)
48+70	-	770.9'
50+05	-	-
51+86	783.7'	783.7'
55+60	785.7'	785.7'
58+52	-	787.3'
58+70	-	787.8'
58+80	-	788.1'
58+92	-	788.4'
59+55	-	788.4'

LEVEE OVERBUILD

OVERBUILD HEIGHT	LEFT LEVEE STATION RANGE	RIGHT LEVEE STATION RANGE
0.25'	53+00 TO 55+00	
0.5'		51+86 TO 58+00
1.0'	51+88 TO 52+60	58+00 TO 60+00

NOTES:

1. ALL ELEVATIONS SHOWN ARE MSL 1929 ADJ.
2. LOCATION OF U.G. TEL., WATER, GAS, SEWER, & ELECT. SERVICE LINES IN TRAILER PARK UNKNOWN.
3. SEE DETAIL PLATE 13 FOR LEVEE OVERBUILD
4. 1 MOBILE HOME AND 1 GARAGE TO BE REMOVED OR PLACE RETAINING WALL AND ACCESS ROAD
5. 5 MOBILE HOMES AND 4 GARAGES TO BE REMOVED
6. 2 MOBILE HOMES AND 1 GARAGE TO BE REMOVED



REFERENCES:

		PLATE NO.
1.	LOCATION MAP, VICINITY MAP, & DRAWING INDEX	1
2.	GENERAL PLAN	2
3.	BORING LOGS	D1-D16
4.	GATEWELL "E"	31,33
5.	TYPICAL SECTIONS	17
6.	MISCELLANEOUS DETAILS	19
7.	BIKE TRAIL DETAILS	19
8.	STORM SEWER DETAILS	35
9.	LANDSCAPE PLAN	41

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

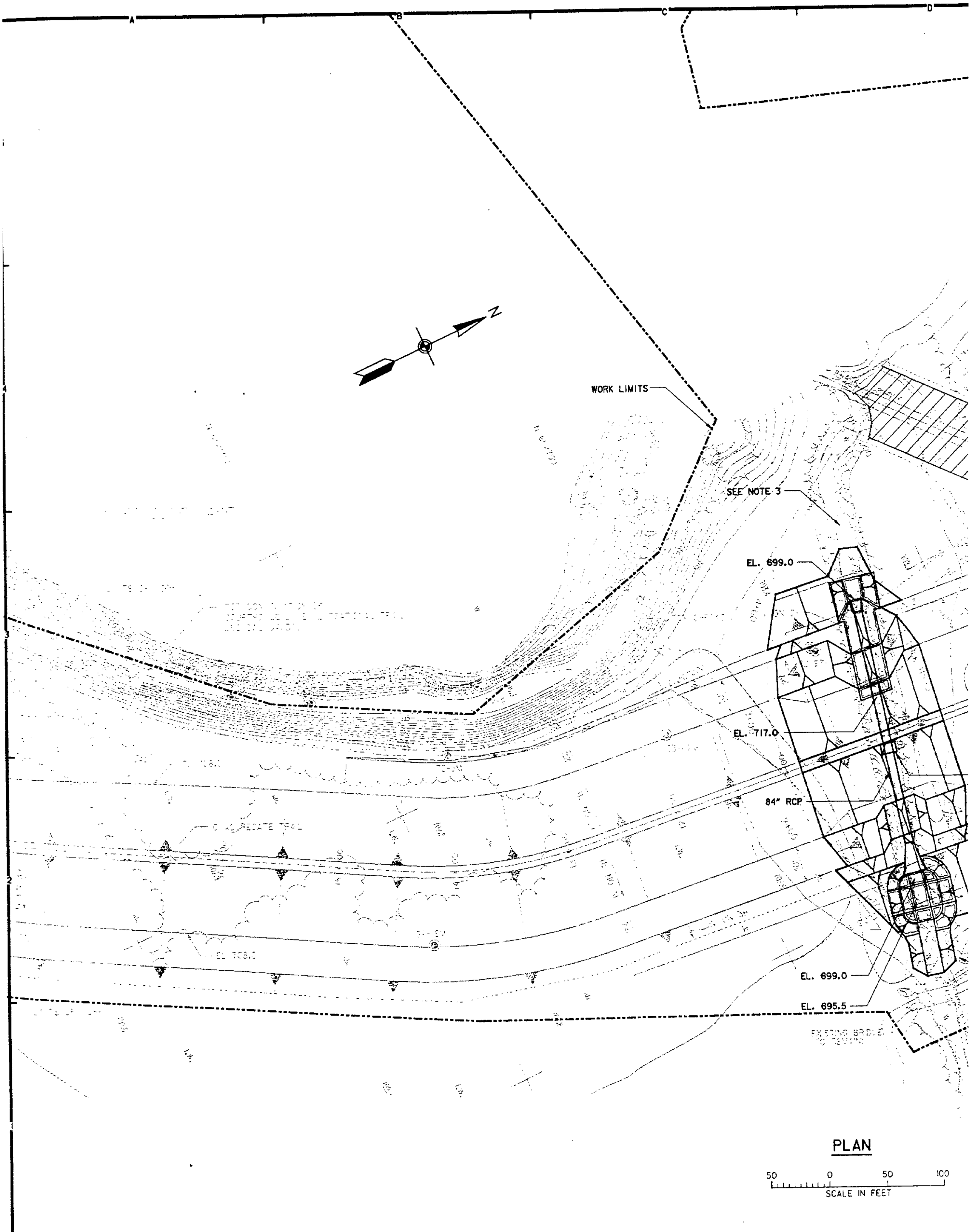
DESIGN MEMORANDUM
CHASKA - STAGE 3
EAST CREEK

CHASKA PROJECT — CHASKA, MINNESOTA

FLOOD CONTROL
PLAN & PROFILE
STA. 50+00 TO 60+00

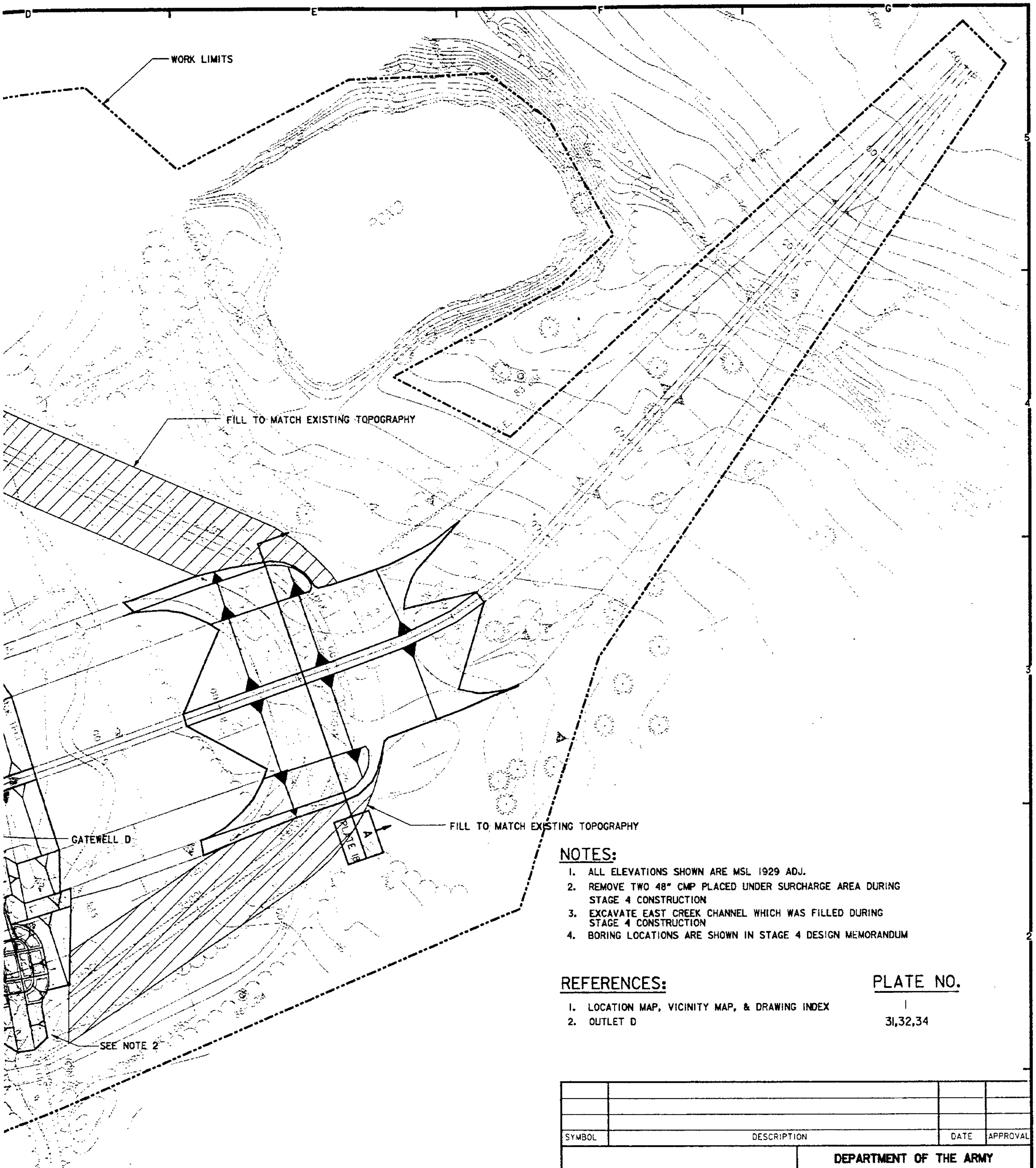
ED-D	DESIGNED:	MB
ED-D	CHECKED:	CR
ED-D	DRAWN:	T.J.
ED-GH	DESIGNED:	
ED-GH	CHECKED:	
	DATE:	12-10-93

CAD FILE NAME: NC05P008.DGN
SPEC NO:
DRAWING NUMBER: PLATE 8
SHT 8 OF 43



WORK LIMITS
SEE NOTE 3
EL. 699.0
EL. 717.0
84" RCP
EL. 699.0
EL. 695.5
PLAN
50 0 50 100
SCALE IN FEET

(1)



NOTES:

1. ALL ELEVATIONS SHOWN ARE MSL 1929 ADJ.
2. REMOVE TWO 48" CMP PLACED UNDER SURCHARGE AREA DURING STAGE 4 CONSTRUCTION
3. EXCAVATE EAST CREEK CHANNEL WHICH WAS FILLED DURING STAGE 4 CONSTRUCTION
4. BORING LOCATIONS ARE SHOWN IN STAGE 4 DESIGN MEMORANDUM

REFERENCES:

REFERENCES	PLATE NO.
1. LOCATION MAP, VICINITY MAP, & DRAWING INDEX	1
2. OUTLET D	31,32,34

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

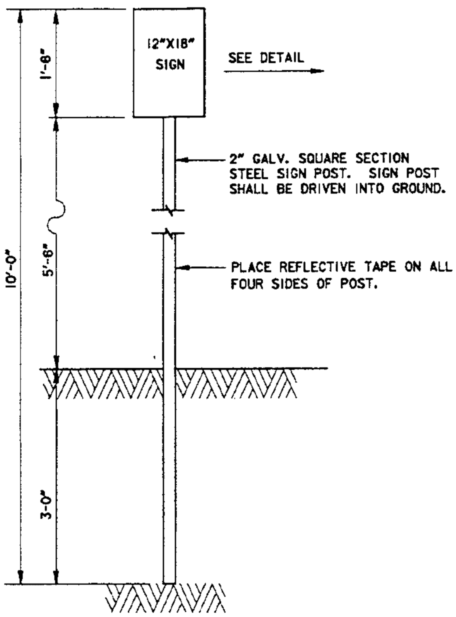
AE APPROVING OFFICIAL:

DESIGN MEMORANDUM
CHASKA - STAGE III
EAST CREEK
CHASKA PROJECT CHASKA, MINNESOTA
FLOOD CONTROL
PLAN - OUTLET 'D'

ED-D	DESIGNED: MB
	CHECKED: CR
	DRAWN: T.J.
ED-GH	DESIGNED:
	CHECKED:
DATE: 12-10-93	

CAD FILE NAME: NC05P009.DGN
SPEC NO: DACW37-90-B-0000
DRAWING NUMBER: PLATE 9
SHT 9 OF 43

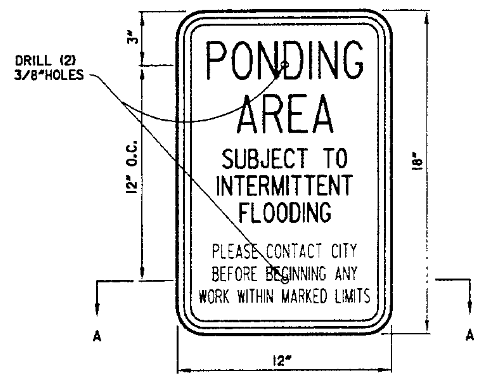
9

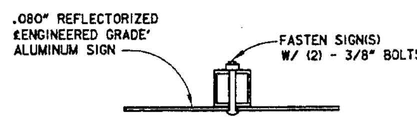


NOTE: INFORMATIONAL SIGNS SUPPLIED BY OTHERS

PONDING AREA INFORMATIONAL SIGN

NO SCALE





SECTION A-A

A

LTS

LEGEND

● - DENOTES PONDING AREA INFORMATIONAL SIGN LOCATIONS

☐ DENOTES PONDING AREA

REFERENCES:

	PLATE NO.
1. LOCATION MAP, VICINITY MAP, & DRAWING INDEX	1

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

ED-D	DESIGNED:	MB
ED-D	CHECKED:	COE
ED-D	DRAWN:	T.J.
ED-GH	DESIGNED:	
ED-GH	CHECKED:	
DATE: 12-10-93		

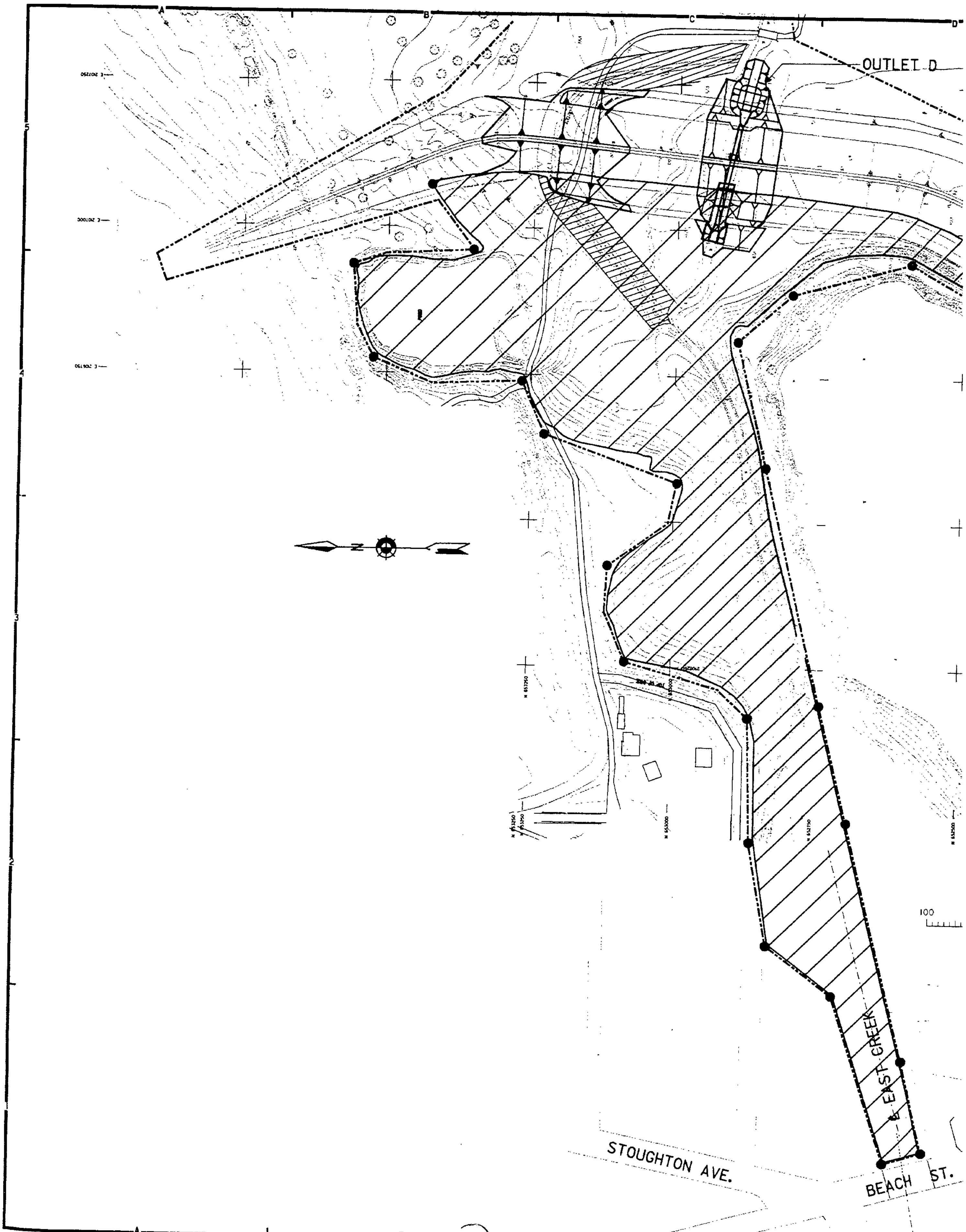
DESIGN MEMORANDUM
CHASKA STAGE 3
EAST CREEK

CHASKA PROJECT — CHASKA, MINNESOTA

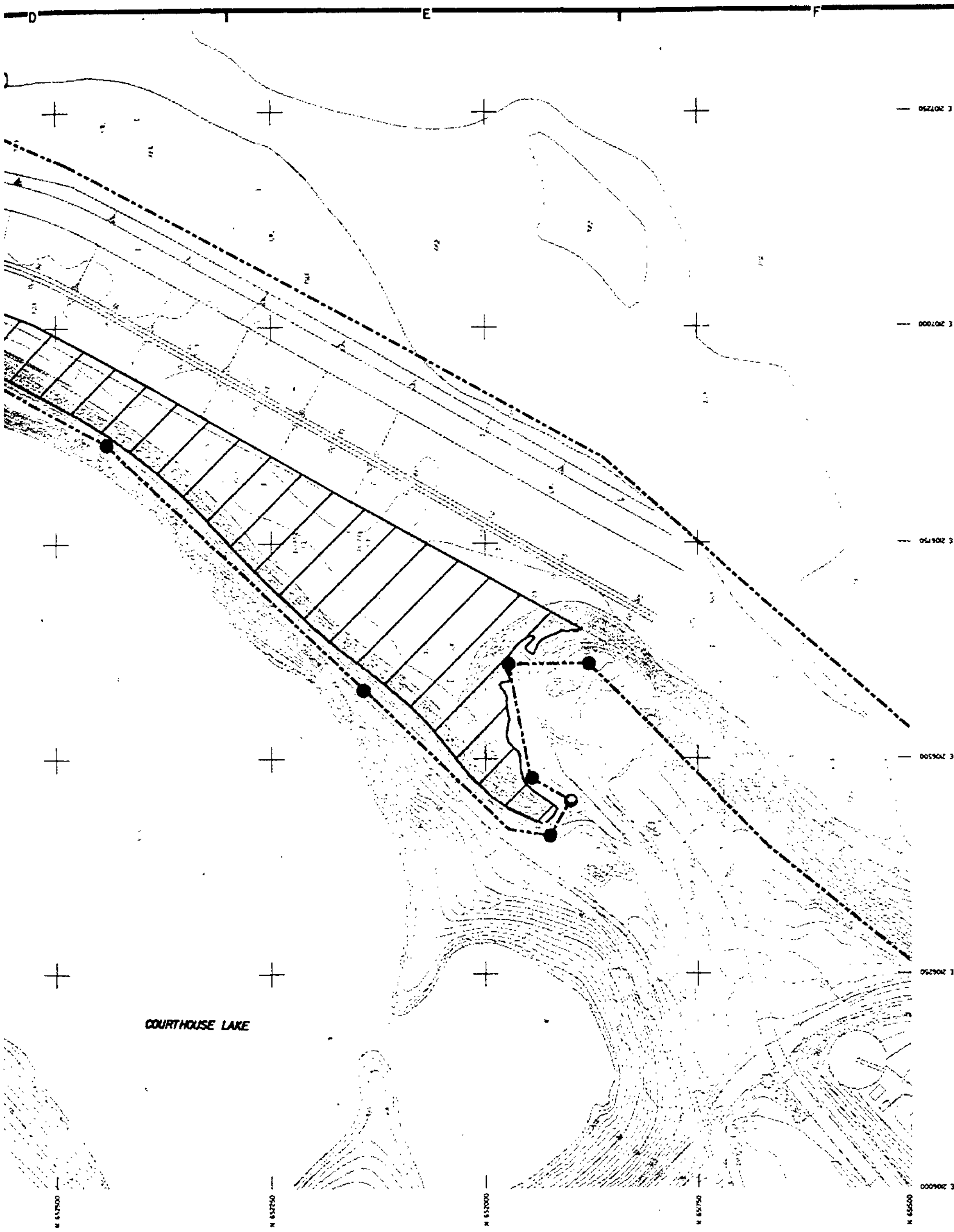
FLOOD CONTROL
PONDING SIGN DETAILS

CAD FILE NAME: NC05P10.DGN	DRAWING NUMBER:	SHT 10
SPEC NO: DACW37-90-B-0000	PLATE 10	OF 43

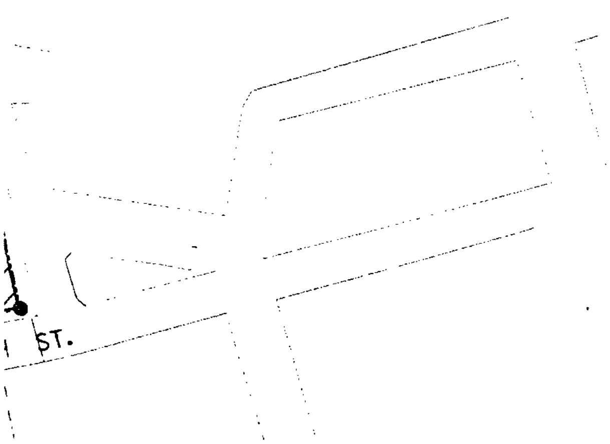
9



(1)



100 0 100 200
SCALE IN FEET



LEGEND

● - DENOTES PONDING AREA INFORMATIONAL SIGN LOCATIONS

▧ DENOTES PONDING AREA

---·---·-- DENOTES WORK LIMITS

REFERENCES:

	PLATE NO.
1. LOCATION MAP, VICINITY MAP, & DRAWING INDEX	1

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

DESIGN MEMORANDUM
CHASKA STAGE 3
EAST CREEK

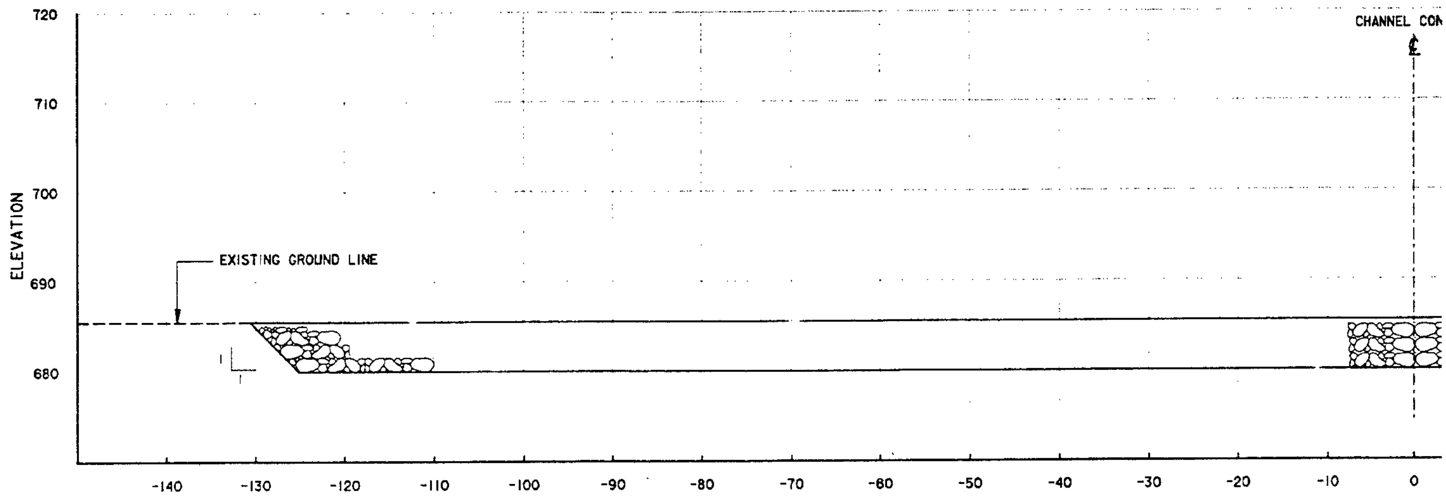
CHASKA PROJECT — CHASKA, MINNESOTA

FLOOD CONTROL
PONDING PLAN-OUTLET 'D'

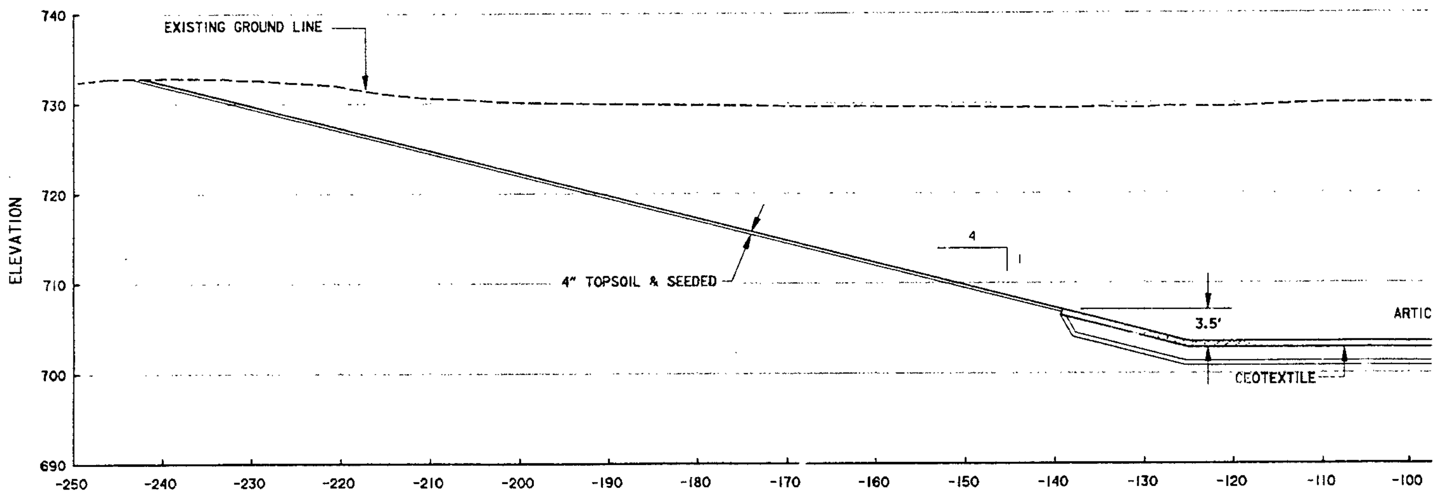
ED-D	DESIGNED:	MB
ED-D	CHECKED:	COL
ED-D	DRAWN:	T.J.
ED-GH	DESIGNED:	
ED-GH	CHECKED:	
DATE:	12-10-93	

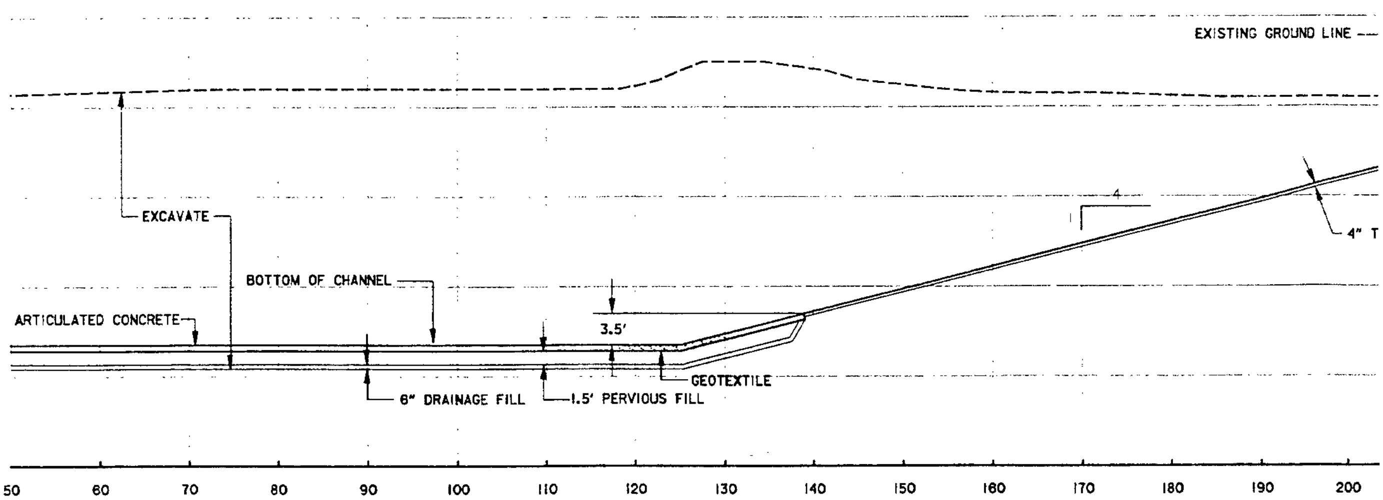
CAD FILE NAME: NCO5POII.DGN	DRAWING NUMBER:	SHT 11
SPEC NO: DACW37-90-B-0000	PLATE 11	OF 43

(2)



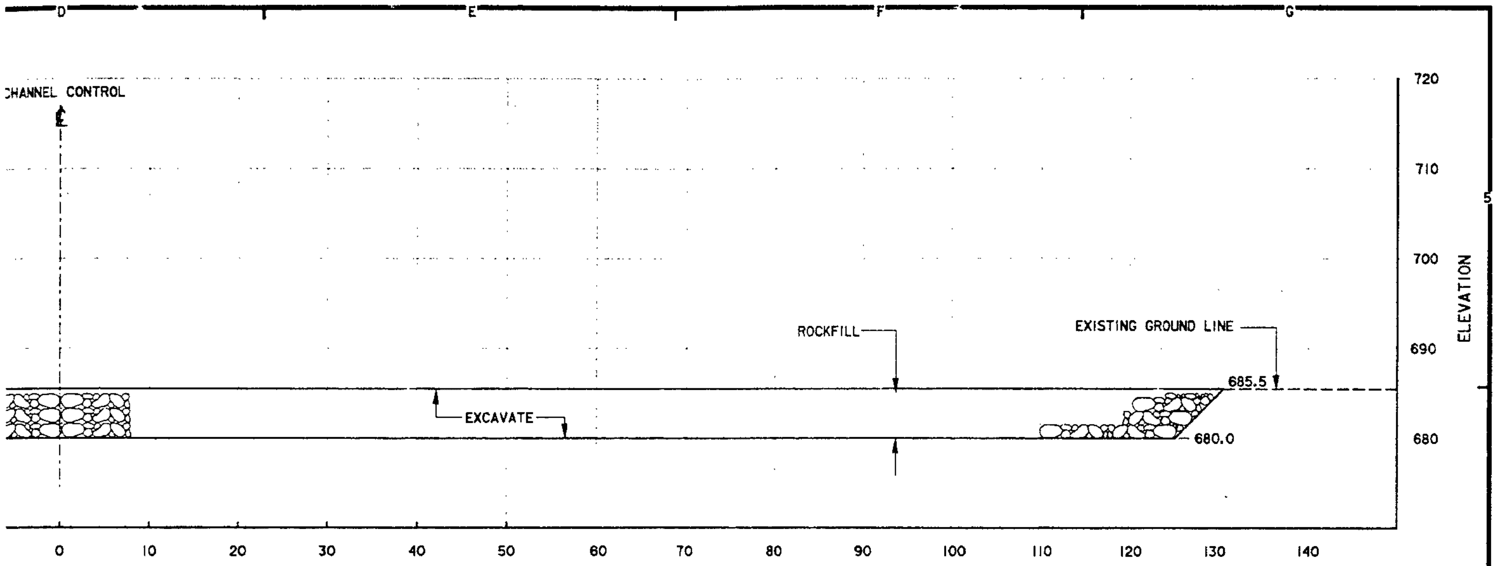
TYPICAL SECTION
STA. -0+28 TO STA. -0+5
SCALE: AS SHOWN



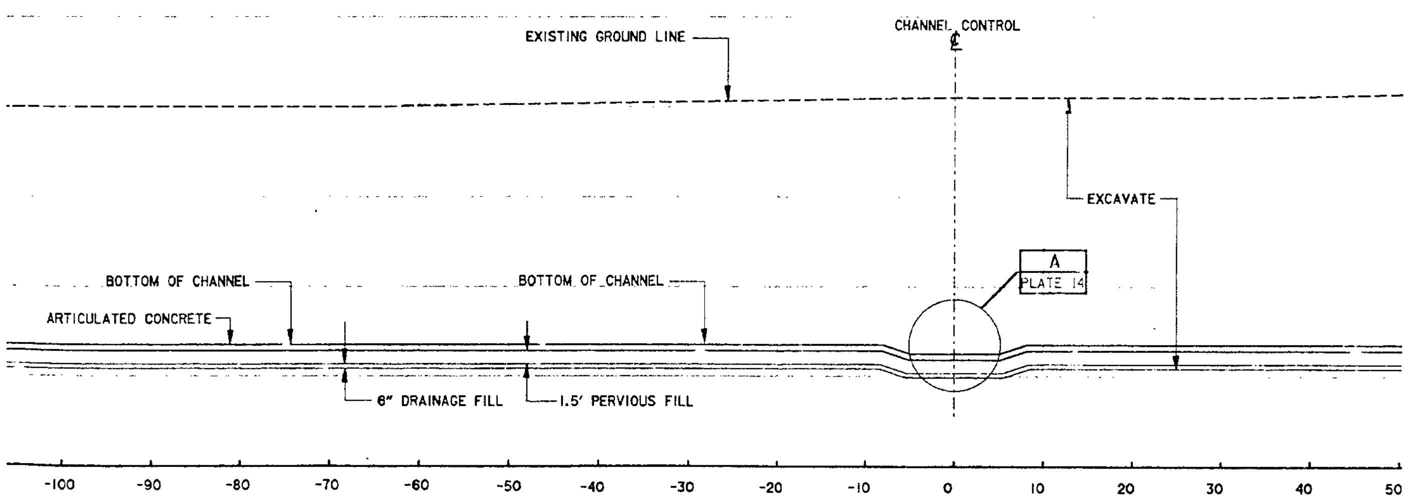


TYPICAL SECTION
STA. 0+50 TO STA. 2+85
SCALE: AS SHOWN

(1)

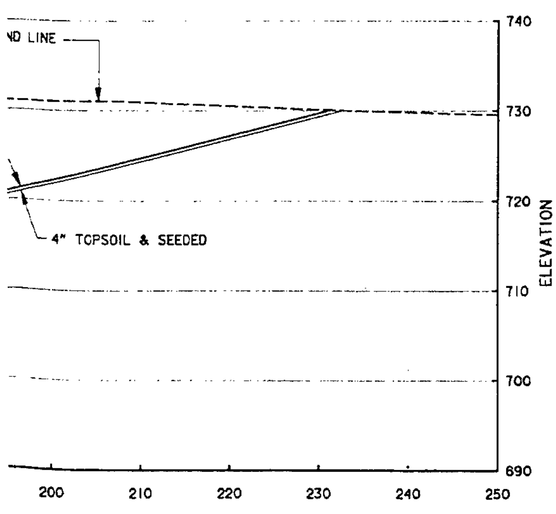


IN
TA. -0+53



NOTES:

1. ELEVATIONS VARY, SEE PROFILE ON PLATE 3
2. ALL ELEVATIONS SHOWN ARE MSL 1929 ADJ.
3. SEE DETAIL H PLATE 19 FOR LANDSCAPE OVERBUILD.



. 2+85

REFERENCES: PLATE NO.

1.	LOCATION MAP, VICINITY MAP, & DRAWING INDEX	1
2.	GENERAL PLAN	2
3.	PLAN AND PROFILE STA. 0+00 TO 10+00	3
4.	MISCELLANEOUS DETAILS	19

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

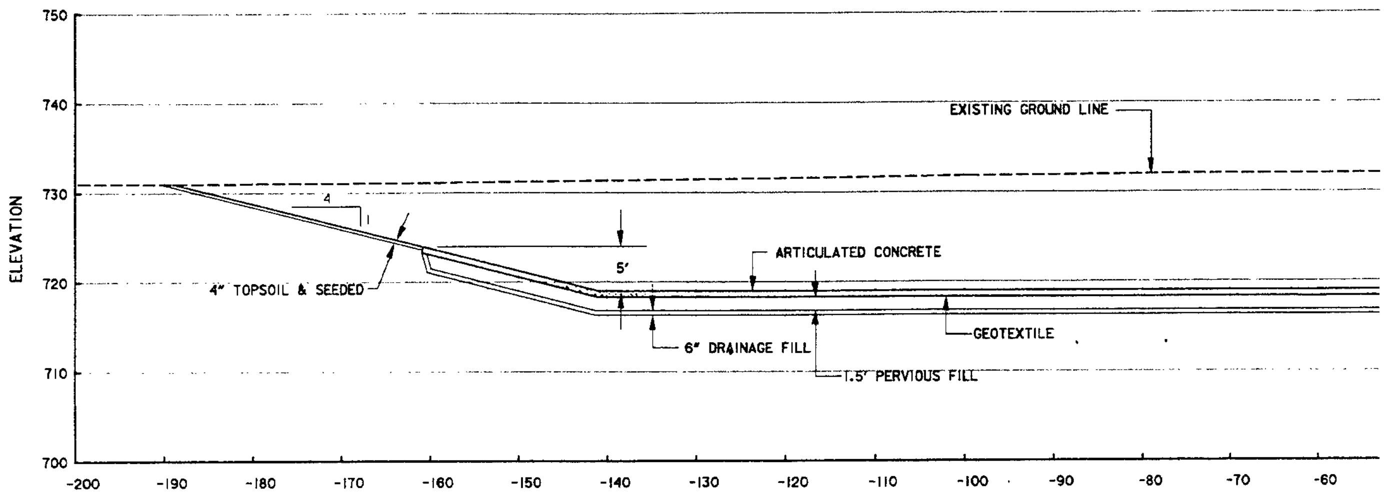
AE APPROVING OFFICIAL:

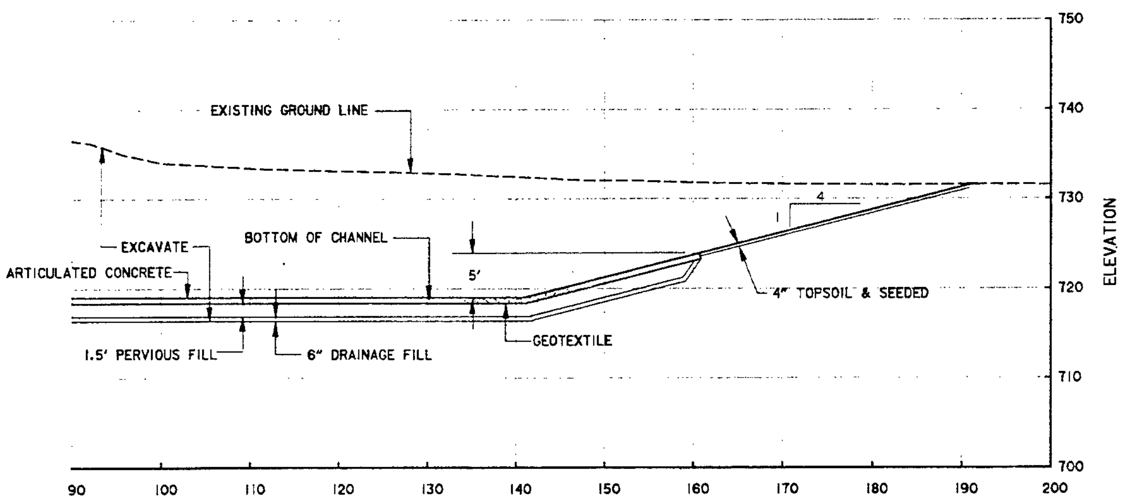
DESIGN MEMORANDUM
CHASKA - STAGE 3
EAST CREEK
CHASKA PROJECT CHASKA, MINNESOTA
FLOOD CONTROL
TYPICAL SECTIONS
STA. -0+28 TO 2+85

ED-D	DESIGNED:	MB
	CHECKED:	CA
	DRAWN:	T.J.
ED-GH	DESIGNED:	JRC/CB
	CHECKED:	

DATE: 12-10-93
CAD FILE NAME: NC05P012.DGN
SPEC NO:
DRAWING NUMBER: PLATE 12
SHT 12 OF 43

(2)

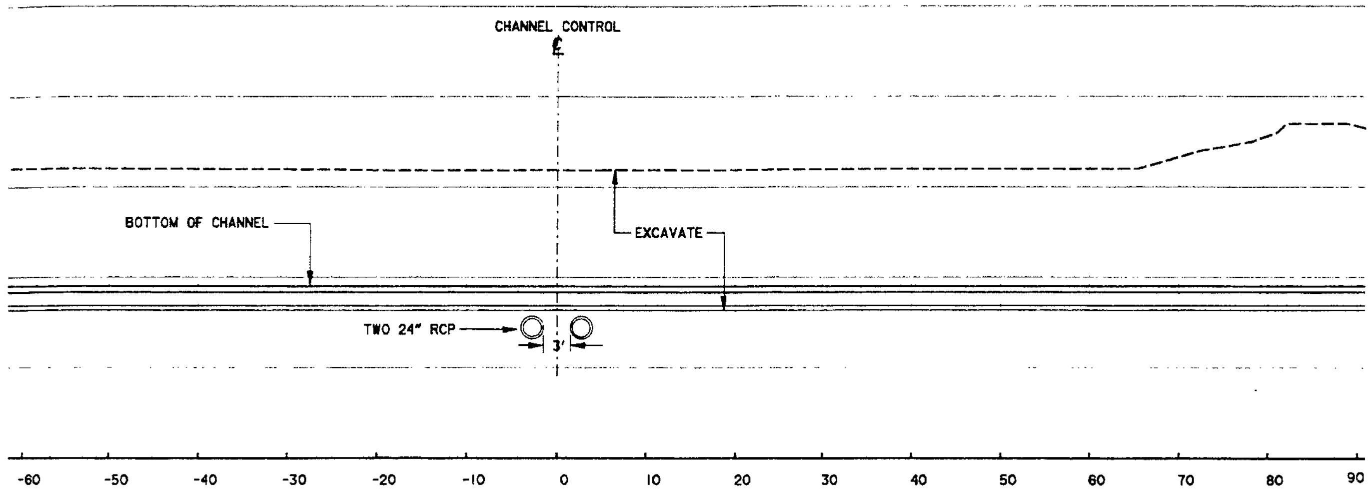


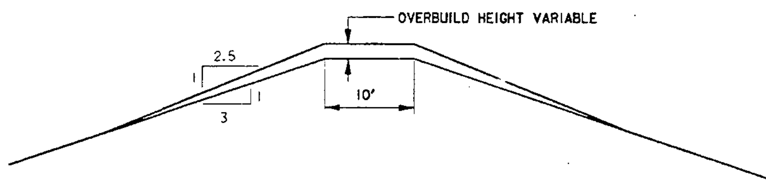


TYPICAL SECTION

STA. 3+50 TO STA. 3+60

SCALE: AS SHOWN





TYPICAL LEVEE OVERBUILD

SCALE: NONE

NOTES:

1. ELEVATIONS VARY, SEE PROFILE ON PLATE 3
2. ALL ELEVATIONS SHOWN ARE MSL 1929 ADJ.
3. SEE DETAIL H PLATE 19 FOR LANDSCAPE OVERBUILD.

REFERENCES:

REFERENCES	PLATE NO.
1. LOCATION MAP, VICINITY MAP, & DRAWING INDEX	1
2. GENERAL PLAN	2
3. PLAN AND PROFILE STA. 0+00 TO 10+00	3
4. MISCELLANEOUS DETAILS	19

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

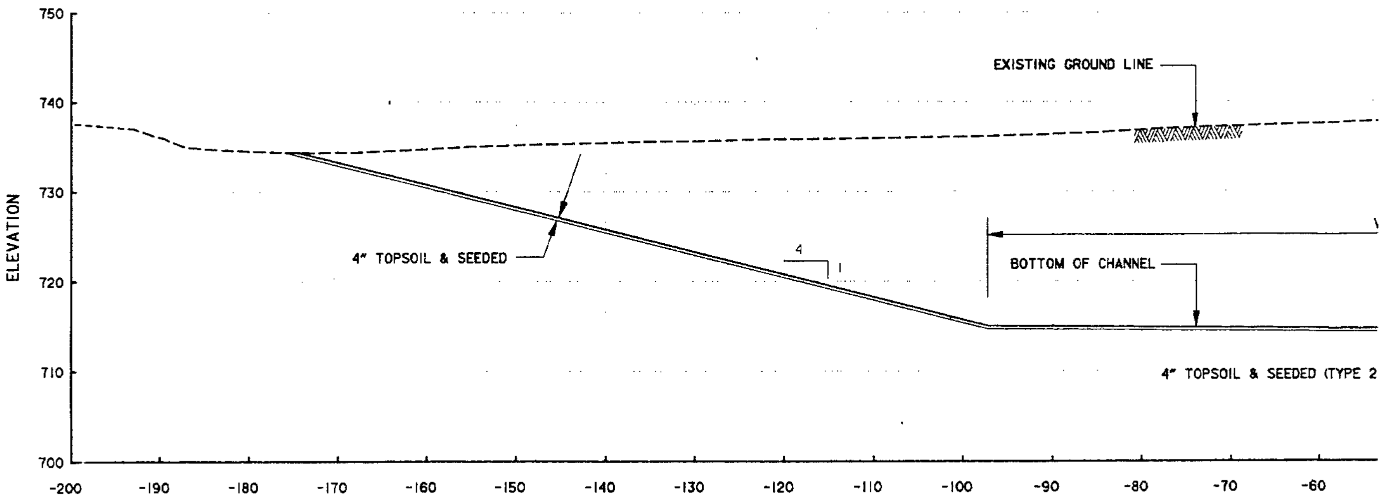
AE APPROVING OFFICIAL:

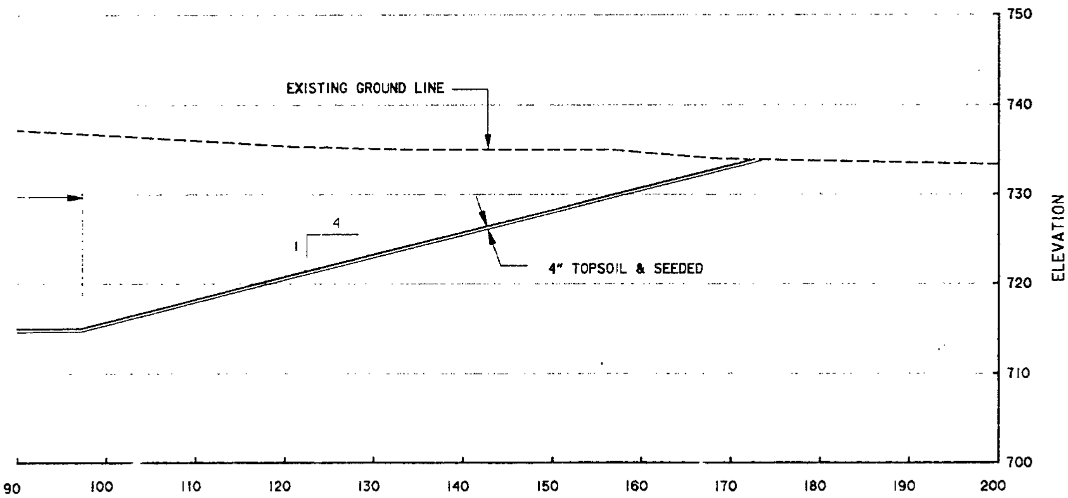
ED-D: DESIGNED: MB; CHECKED: CRC; DRAWN: T.J.
ED-CH: DESIGNED: JRC/CB; CHECKED:
DATE: 12-10-93

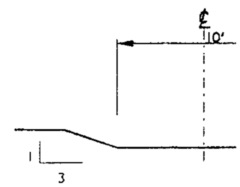
DESIGN MEMORANDUM
CHASKA - STAGE 3
EAST CREEK
CHASKA PROJECT — CHASKA, MINNESOTA
FLOOD CONTROL
TYPICAL SECTION
STA. 3+50 TO 3+60

CAD FILE NAME: NC05P013.DGN
SPEC NO:
DRAWING NUMBER: PLATE 13
SHT 3 OF 43

(9)



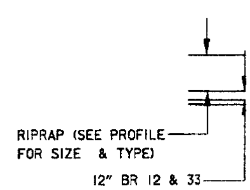




DETAIL

TYPICAL LOW FLOW C

SCALE: NONE



DETAIL

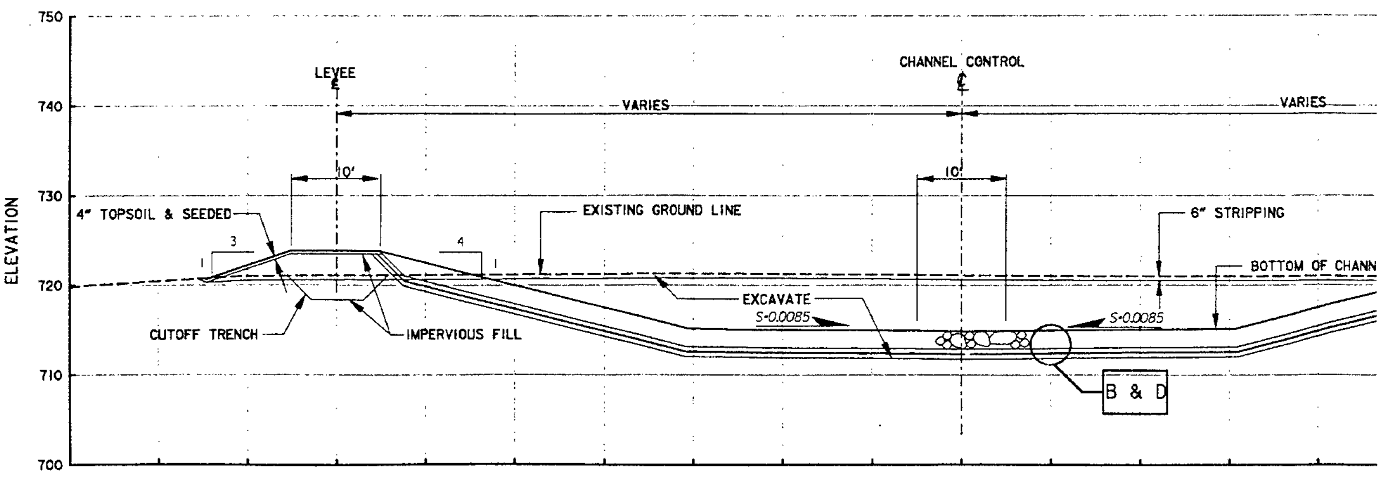
FOR ALL R33 RIPRAP

SCALE: NONE

TYPICAL SECTION

STA. 3+75 TO STA. 6+40

SCALE: AS SHOWN

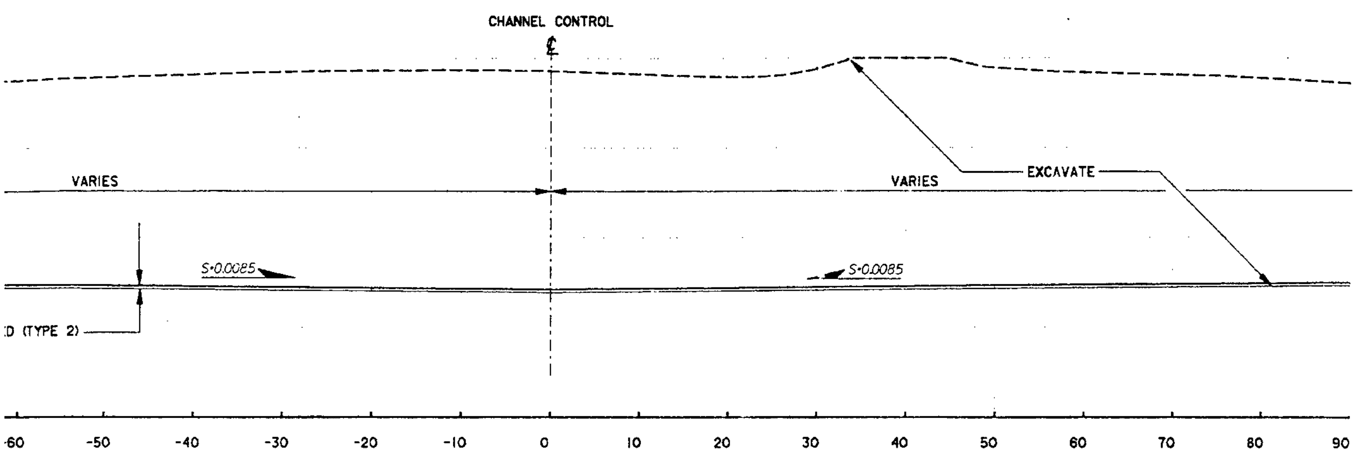


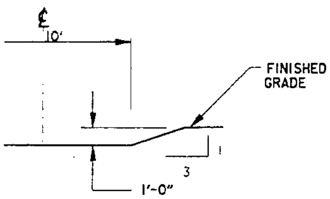
TYPICAL SECTION

STA. 7+25 TO STA. 8+25

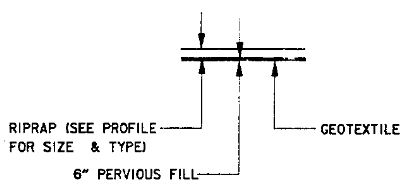
SCALE: AS SHOWN

(1)





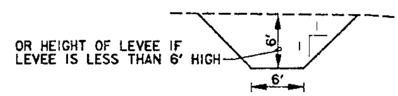
FLOW CHANNEL — A



DETAIL — C

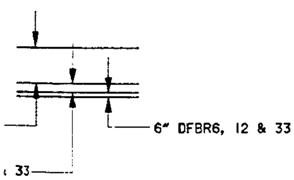
FOR RIPRAP STA. 15+20 TO 25+90

SCALE: NONE

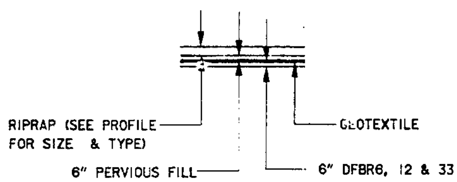


TYPICAL CUTOFF TRENCH

SCALE: NONE



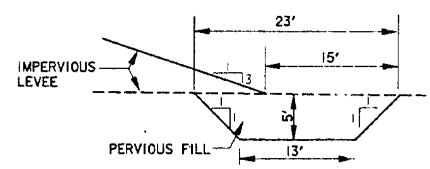
RIPRAP — B



DETAIL — D

FOR ALL OTHER RIPRAP IN CHANNEL

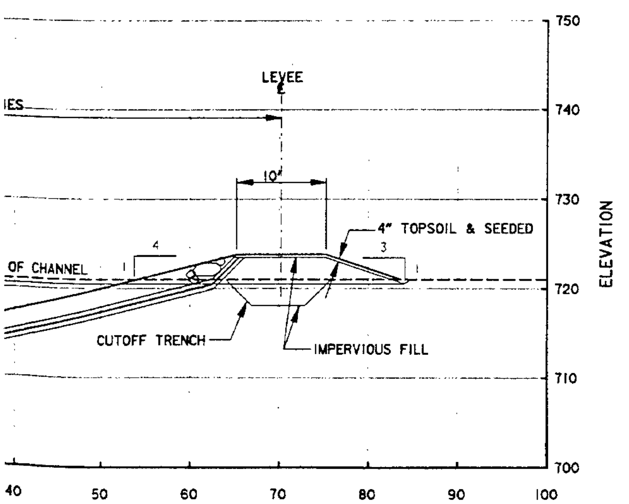
SCALE: NONE



TYPICAL TOE DRAIN

STATION: 8+62 TO 14+62

SCALE: NONE



NOTES:

1. ELEVATIONS VARY, SEE PROFILE ON PLATE 3
2. ALL ELEVATIONS SHOWN ARE MSL 1929 ADJ.
3. SEE DETAIL H PLATE 19 FOR LANDSCAPE OVERBUILD.

REFERENCES:

		PLATE NO.
1.	LOCATION MAP, VICINITY MAP, & DRAWING INDEX	1
2.	GENERAL PLAN	2
3.	PLAN AND PROFILE STA. 0+00 TO 10+00	3
4.	MISCELLANEOUS DETAILS	19

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

DESIGN MEMORANDUM
CHASKA - STAGE 3
EAST CREEK
CHASKA PROJECT — CHASKA, MINNESOTA
FLOOD CONTROL
TYPICAL SECTIONS
STA. 3+73 TO 8+25

ED-D: DESIGNED: MB; CHECKED: COE; DRAWN: T.J.
ED-GH: DESIGNED: JRC/CB; CHECKED:

DATE: 12-10-93

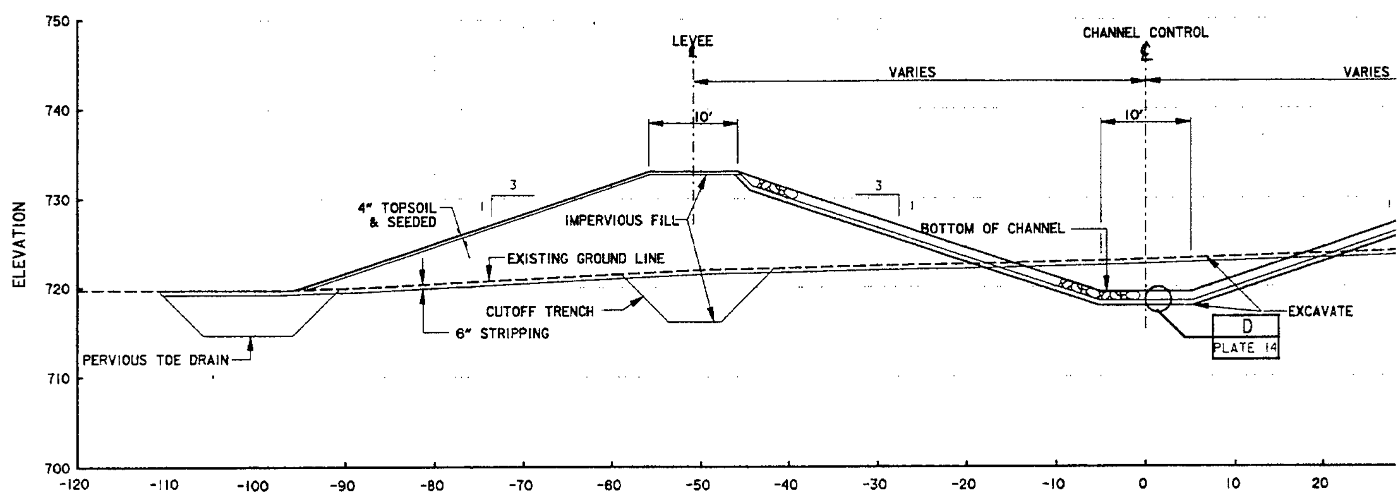
CAD FILE NAME: NCOSP014.DGN

SPEC NO:

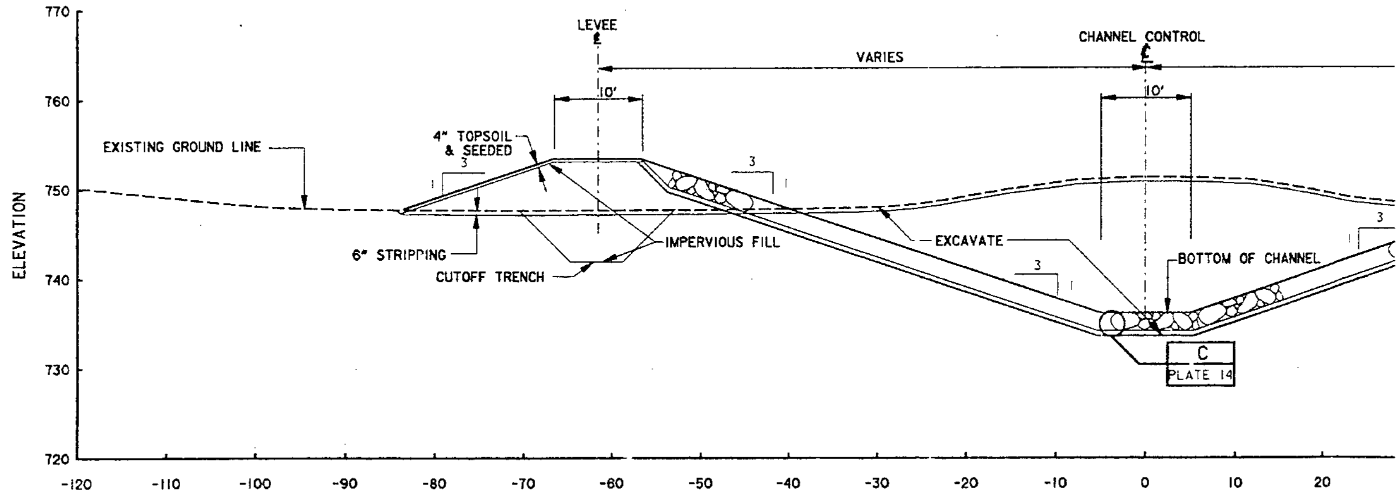
DRAWING NUMBER: PLATE 14

SHT 14 OF 43

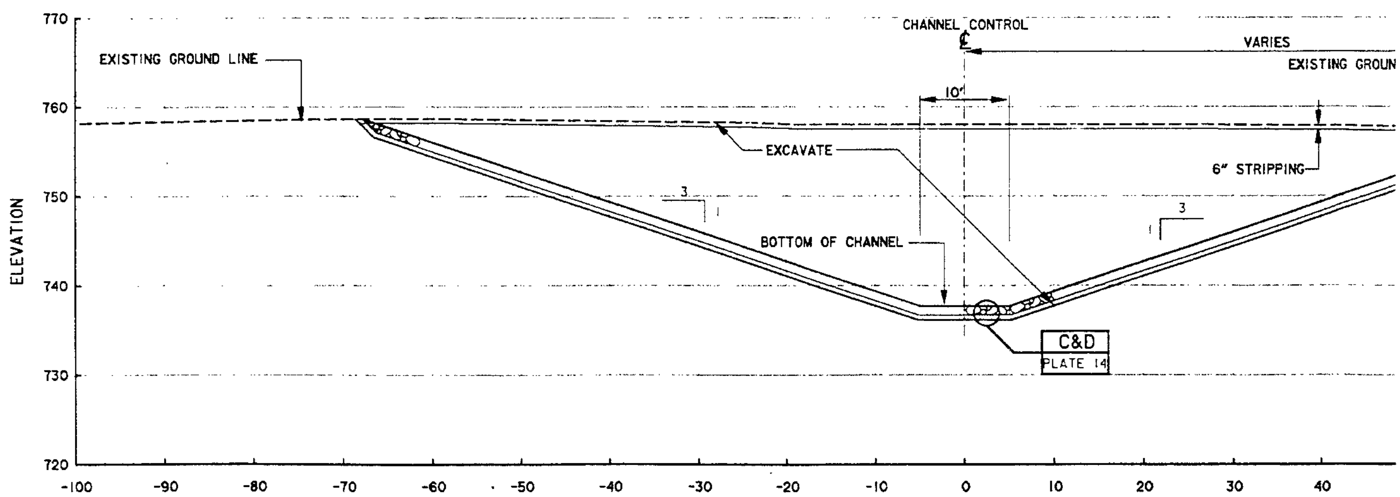
(2)



TYPICAL SECTION
STA. 9+22 TO STA. 14+02
SCALE: AS SHOWN

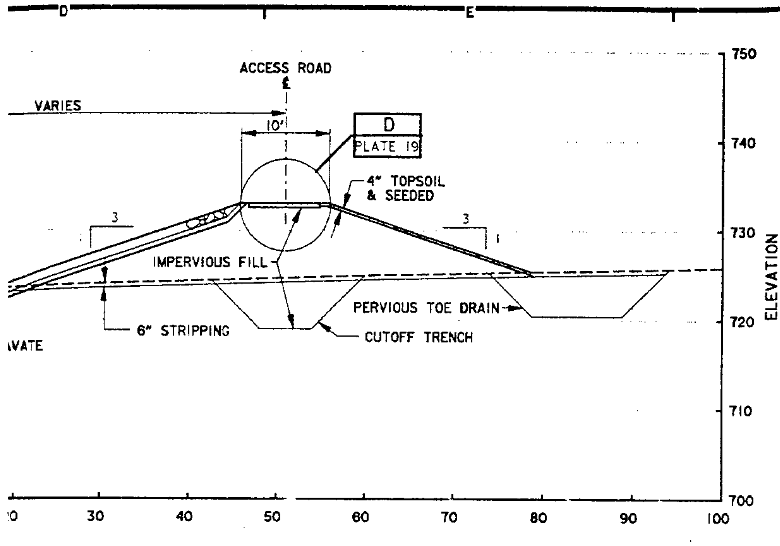


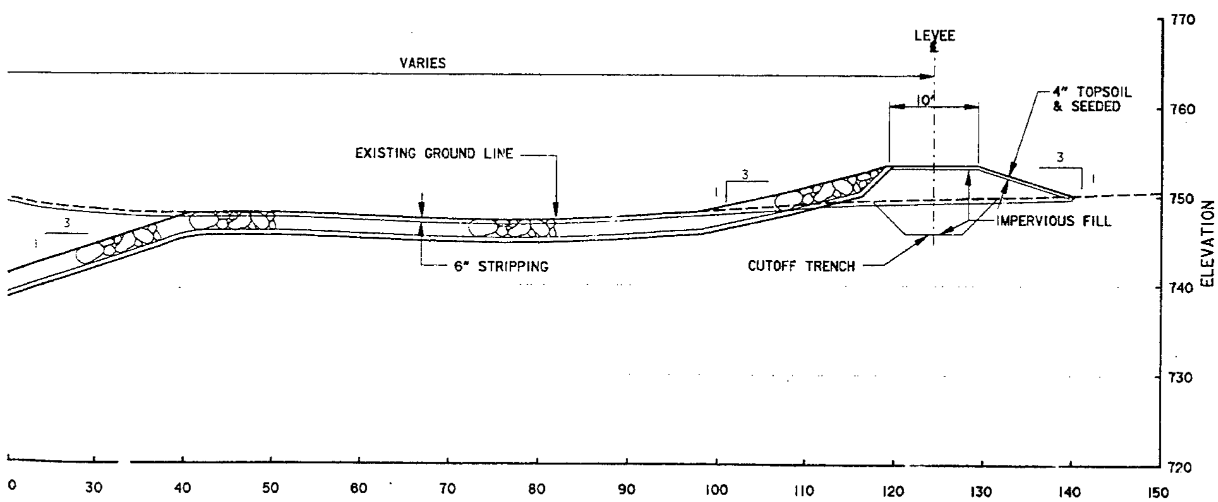
TYPICAL SECTION
STA. 15+60 TO STA. 16+08
SCALE: AS SHOWN

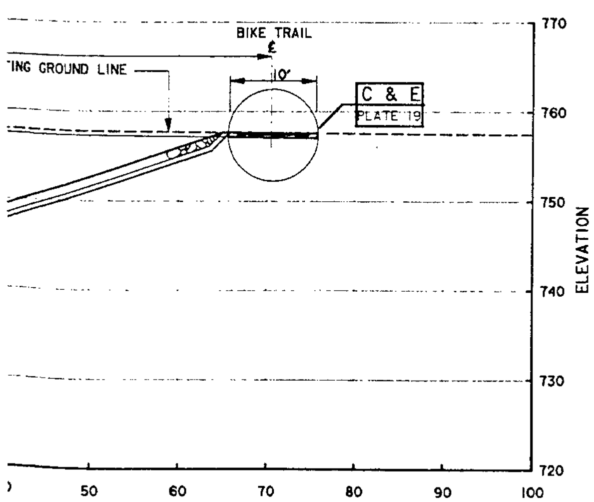


TYPICAL SECTION
STA. 17+20 TO STA. 28+70 &
STA. 29+60 TO STA. 30+60
SCALE: AS SHOWN

1







NOTES:

1. ELEVATIONS VARY, SEE PROFILE ON PLATE 3-6.
2. ALL ELEVATIONS SHOWN ARE MSL 1929 ADJ.
3. SEE DETAIL H PLATE 19 FOR LANDSCAPE OVERBUILD.

REFERENCES:

		PLATE NO.
1.	LOCATION MAP, VICINITY MAP, & DRAWING INDEX	1
2.	GENERAL PLAN	2
3.	PLAN AND PROFILE STA. 0+00 TO 10+00, 10+00 TO 20+00, 20+00 TO 30+00 & 30+00 TO 40+00	3,4,5 & 6
4.	TOE DRAIN DETAILS	14
5.	MISCELLANEOUS DETAILS	19

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

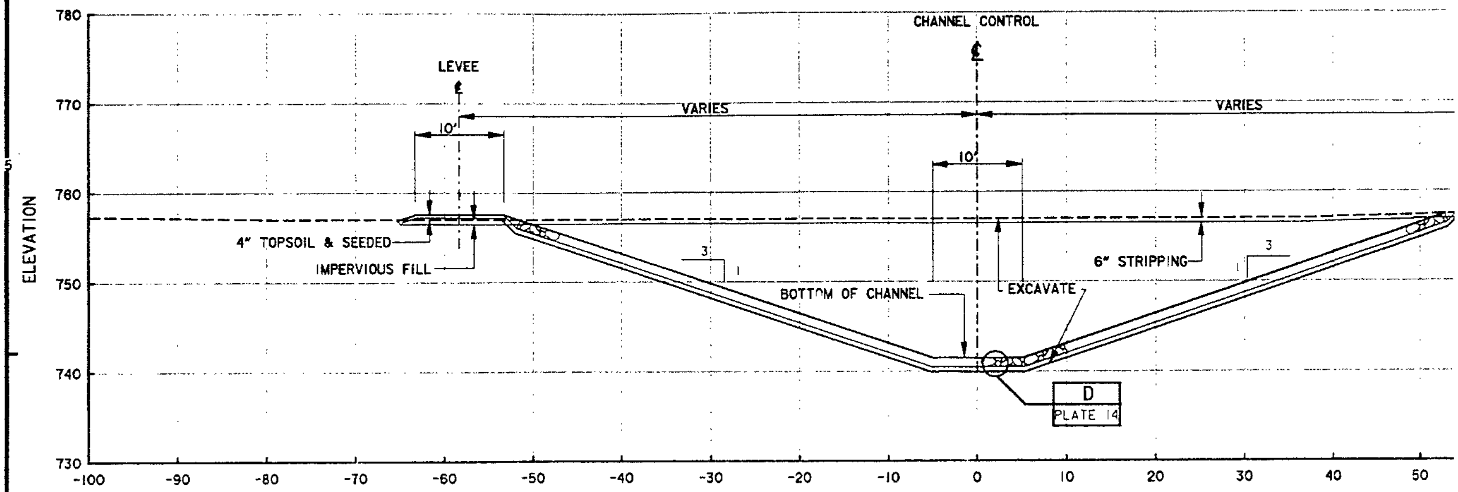
AE APPROVING OFFICIAL:

DESIGN MEMORANDUM
CHASKA - STAGE 3
EAST CREEK
CHASKA PROJECT CHASKA, MINNESOTA
FLOOD CONTROL
TYPICAL SECTIONS
STA. 9+72 TO 30+60

ED-D	DESIGNED:	MB
	CHECKED:	cor
	DRAWN:	T.J.
ED-GH	DESIGNED:	JRC/CB
	CHECKED:	

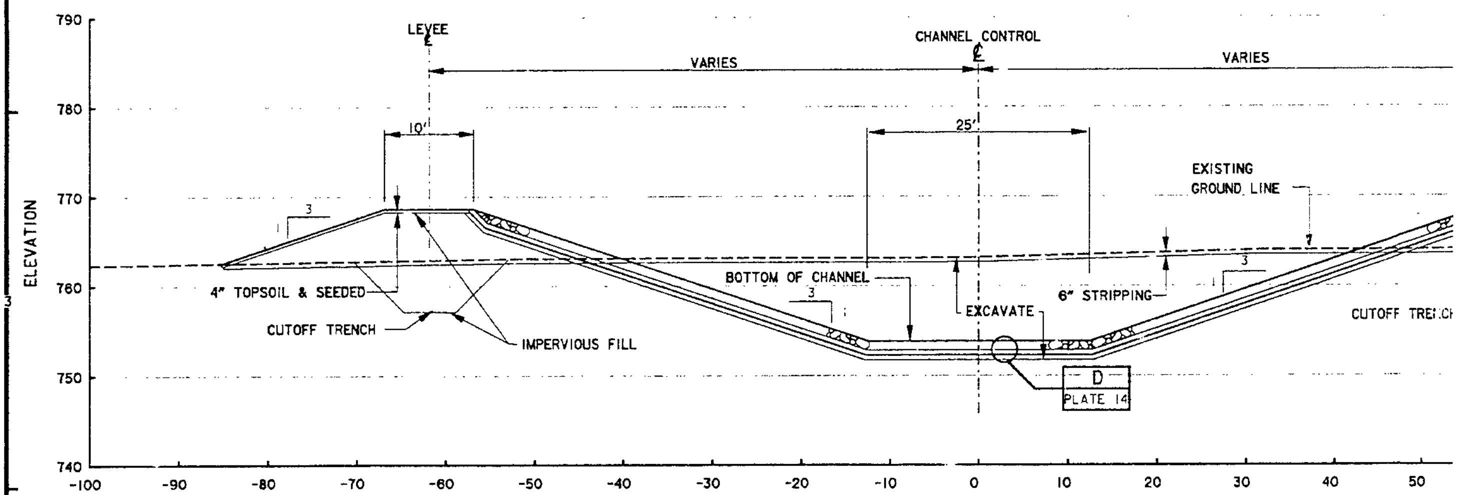
DATE: 12-10-93
CAD FILE NAME: NC05P015.DGN
SPEC NO:
DRAWING NUMBER: PLATE 15
SHT 15 OF 43

2



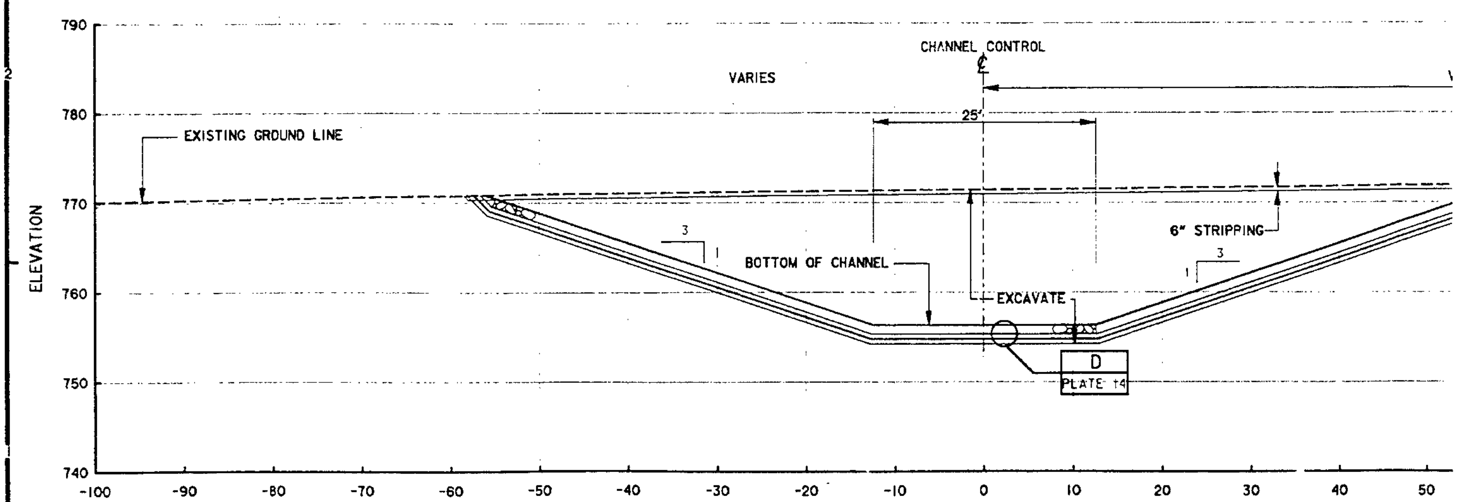
TYPICAL SECTION

STA. 28+70 TO STA. 29+60 &
STA. 30+60 TO STA. 31+64
SCALE: AS SHOWN



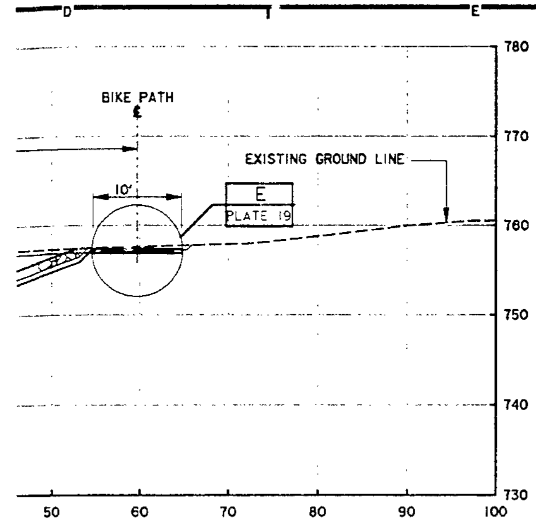
TYPICAL SECTION

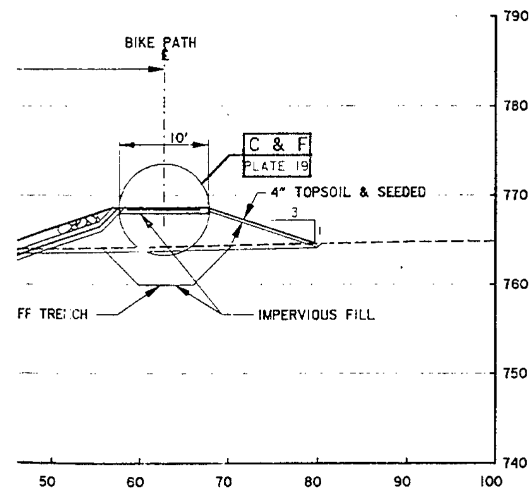
STA. 33+30 TO STA. 45+70
SCALE: AS SHOWN

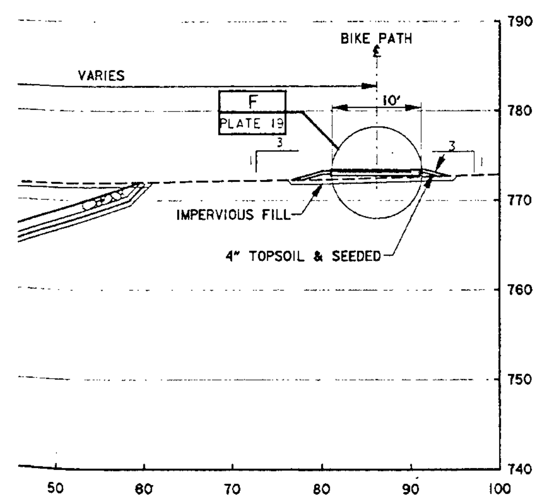


TYPICAL SECTION

STA. 48+70 TO STA. 50+05
SCALE: AS SHOWN







NOTES:

1. ELEVATIONS VARY, SEE PROFILES ON PLATES 5-8
2. ALL ELEVATIONS SHOWN ARE MSL 1929 ADJ.
3. SEE DETAIL H PLATE 19 FOR LANDSCAPE OVERBUILD.

REFERENCES:

	REFERENCES	PLATE NO.
1.	LOCATION MAP, VICINITY MAP, & DRAWING INDEX	1
2.	GENERAL PLAN	2
3.	PLAN AND PROFILE STA. 20+00 TO 30+00, 30+00 TO 40+00, 40+00 TO 50+00 & 50+00 TO 60+00	5,6,7 & 8
5.	MISCELLANEOUS DETAILS	18

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

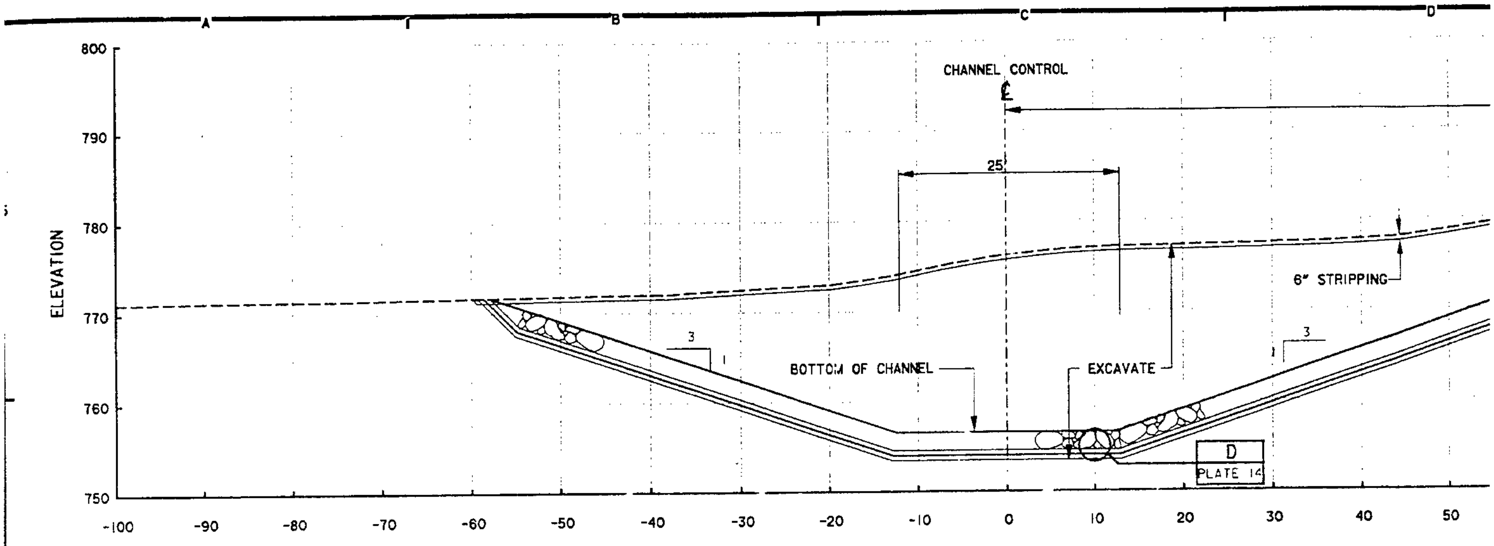
AE APPROVING OFFICIAL:

DESIGN MEMORANDUM
CHASKA - STAGE 3
EAST CREEK
CHASKA PROJECT FLOOD CONTROL CHASKA, MINNESOTA
TYPICAL SECTIONS
STA. 28+70 TO 50+05

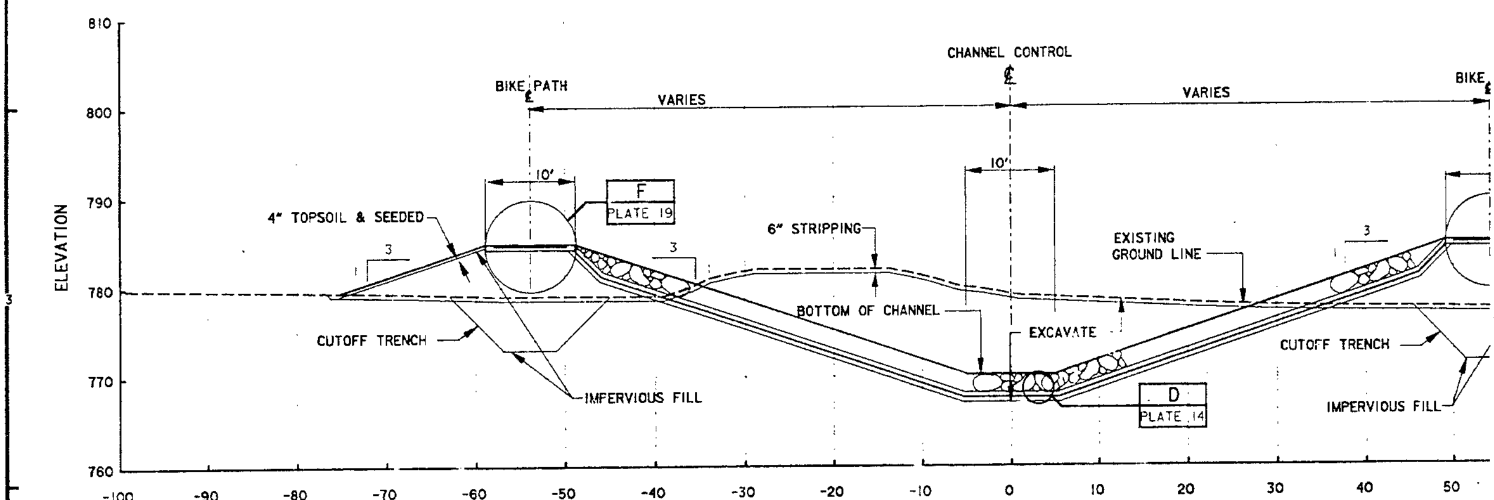
ED-D DESIGNED: MB
CHECKED: CAE
DRAWN: T.J.
ED-GH DESIGNED: JRC/CB
CHECKED:
DATE: 12-10-93

CAD FILE NAME: NC05P016.DGN
SPEC NO:
DRAWING NUMBER: PLATE 16
SHT 16 OF 43

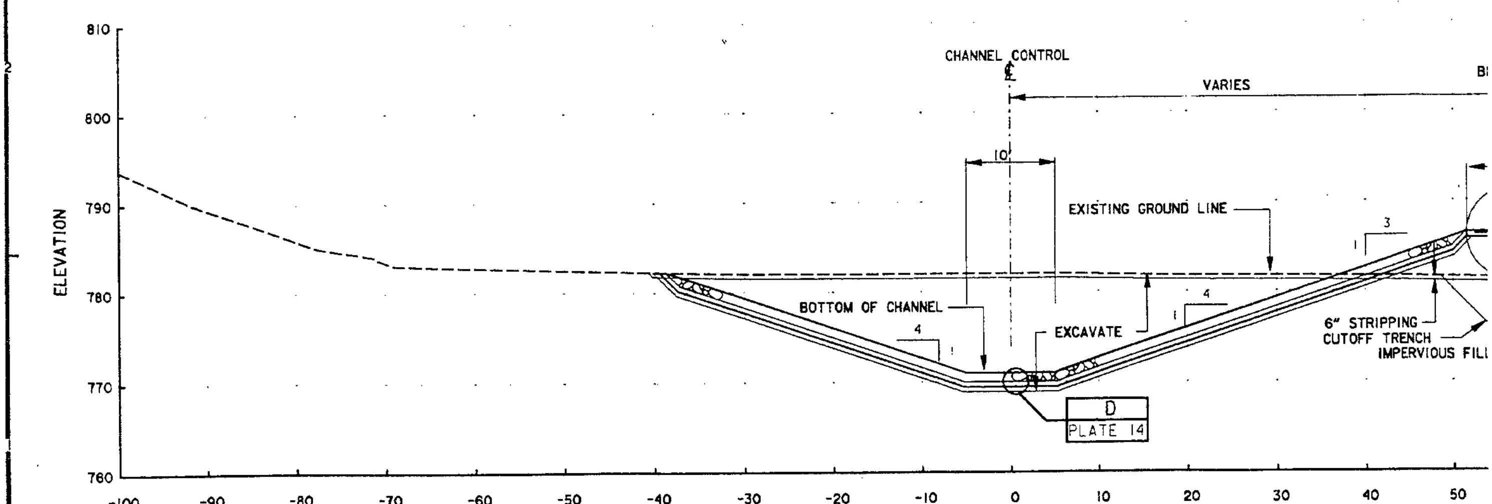
9



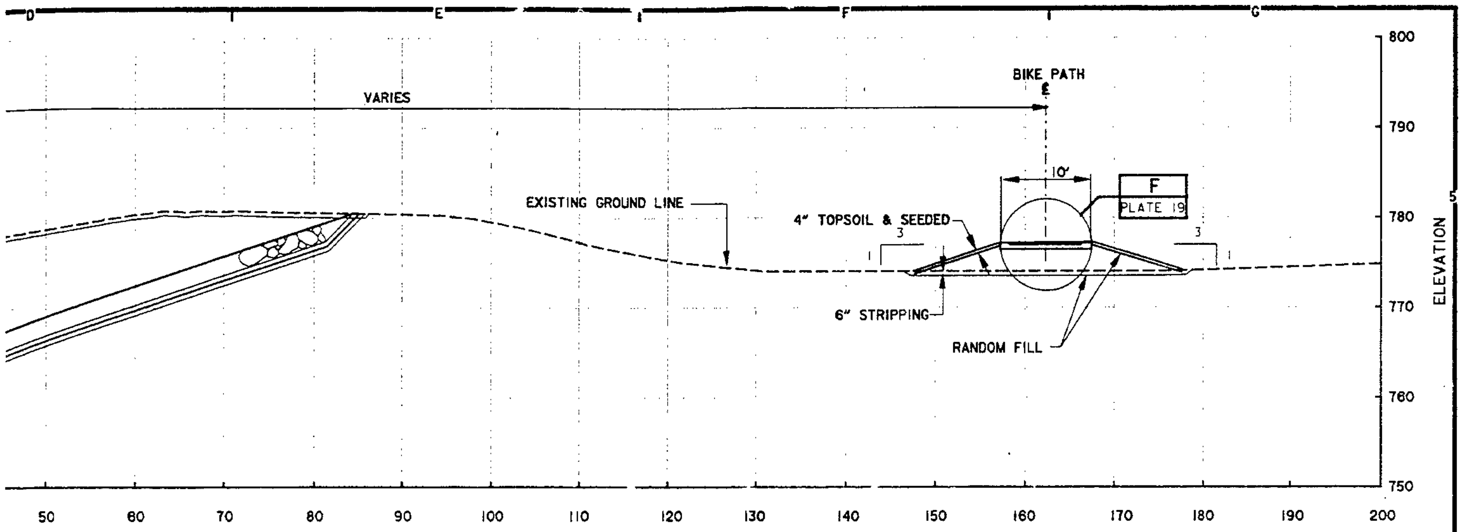
TYPICAL SECTION
STA. 50+05 TO STA. 50+95
SCALE: AS SHOWN

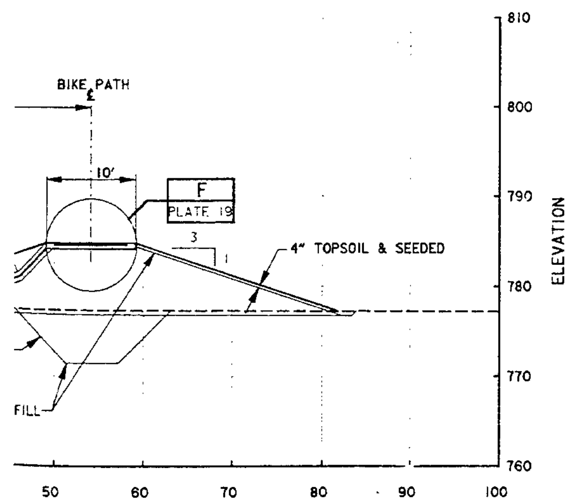


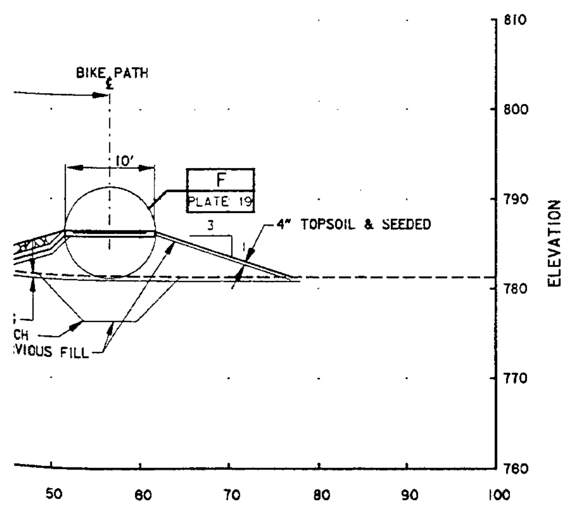
TYPICAL SECTION
STA. 53+40 TO STA. 55+60
SCALE: AS SHOWN



TYPICAL SECTION
STA. 55+60 TO STA. 58+52
SCALE: AS SHOWN







NOTES:

1. ELEVATIONS VARY, SEE PROFILE ON PLATE 8
2. ALL ELEVATIONS SHOWN ARE MSL 1929 ADJ.
3. SEE DETAIL H PLATE 19 FOR LANDSCAPE OVERBUILD.

REFERENCES:	PLATE NO.
1. LOCATION MAP, VICINITY MAP, & DRAWING INDEX	1
2. GENERAL PLAN	2
3. PLAN AND PROFILE STA. 50+00 TO 60+00	8
5. MISCELLANEOUS DETAILS	19

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

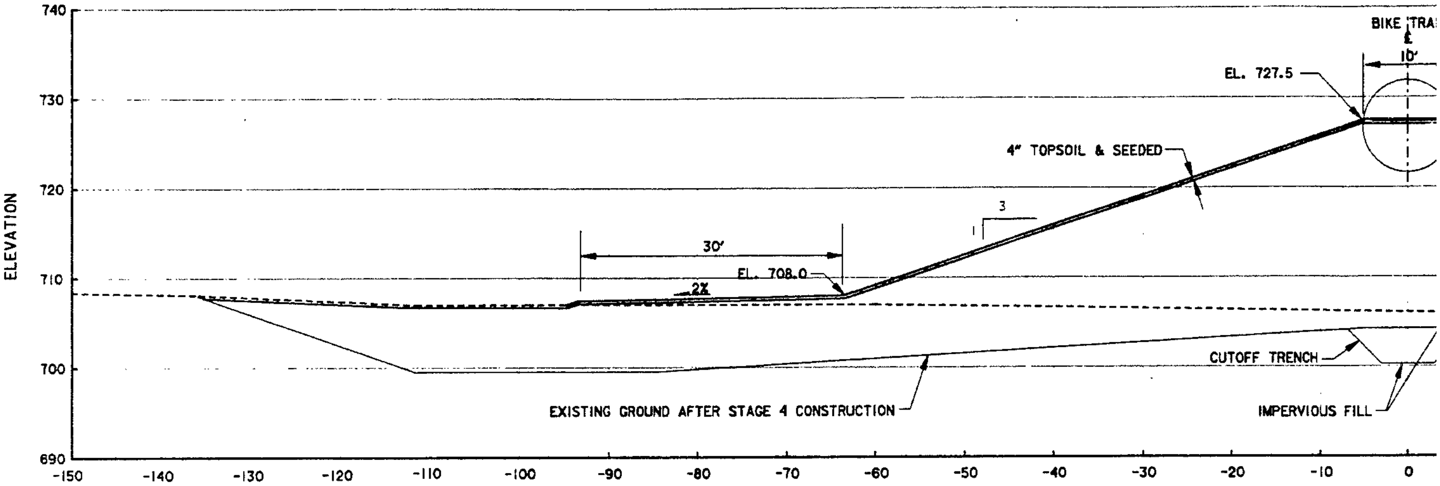
AE APPROVING OFFICIAL:

DESIGN MEMORANDUM
CHASKA - STAGE 3
EAST CREEK
CHASKA PROJECT — CHASKA, MINNESOTA
FLOOD CONTROL
TYPICAL SECTIONS
STA. 50+05 TO 58+80

ED-D: DESIGNED: MB; CHECKED: cac; DRAWN: JRC/CB
ED-GH: DESIGNED: T.J.; CHECKED:
DATE: 12-10-93

CAD FILE NAME: NC05P017.DGN
SPEC NO:
DRAWING NUMBER: PLATE 17
SHT 17 OF 43

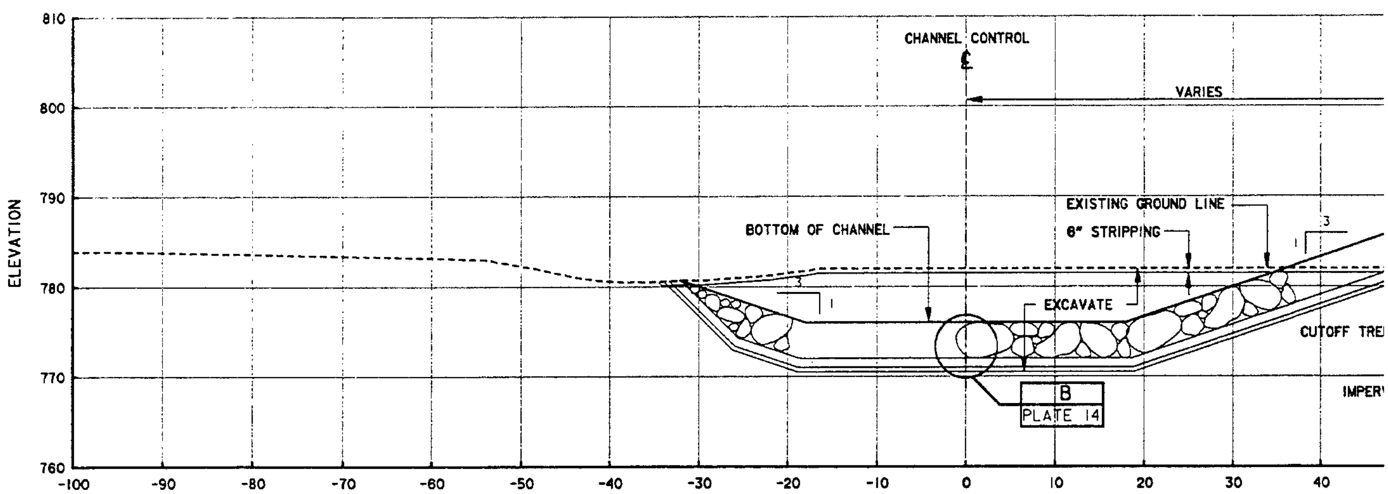
(7)



DETAIL SECTI

OUTLET D LEVE

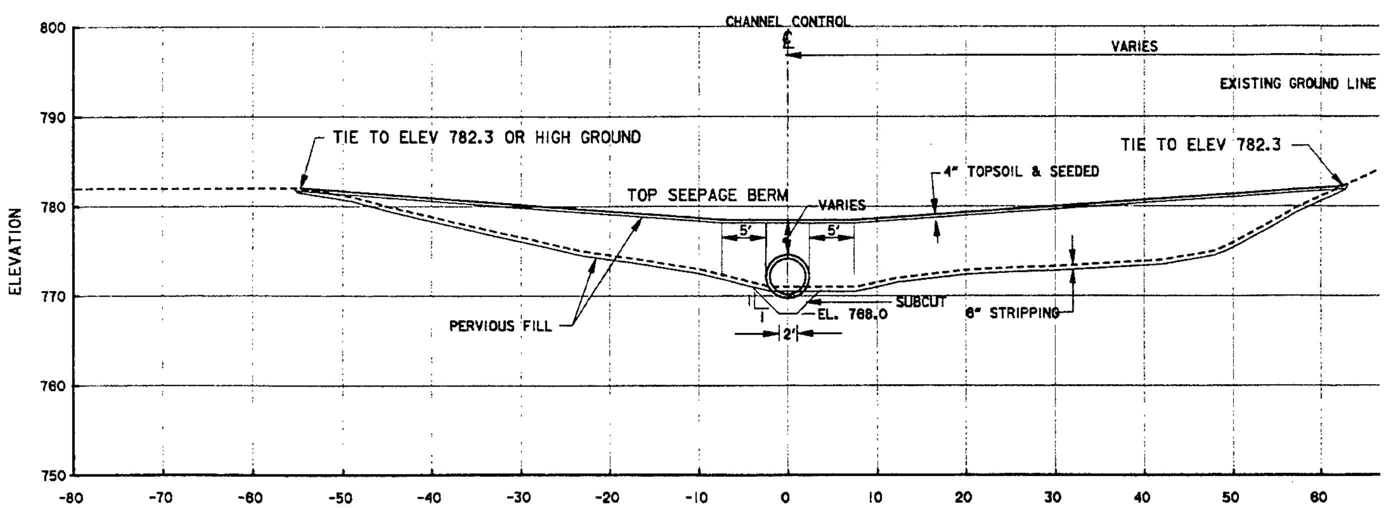
SCALE: AS SHOWN



TYPICAL SECTION

STA. 58+70 TO STA. 58+80

SCALE: AS SHOWN

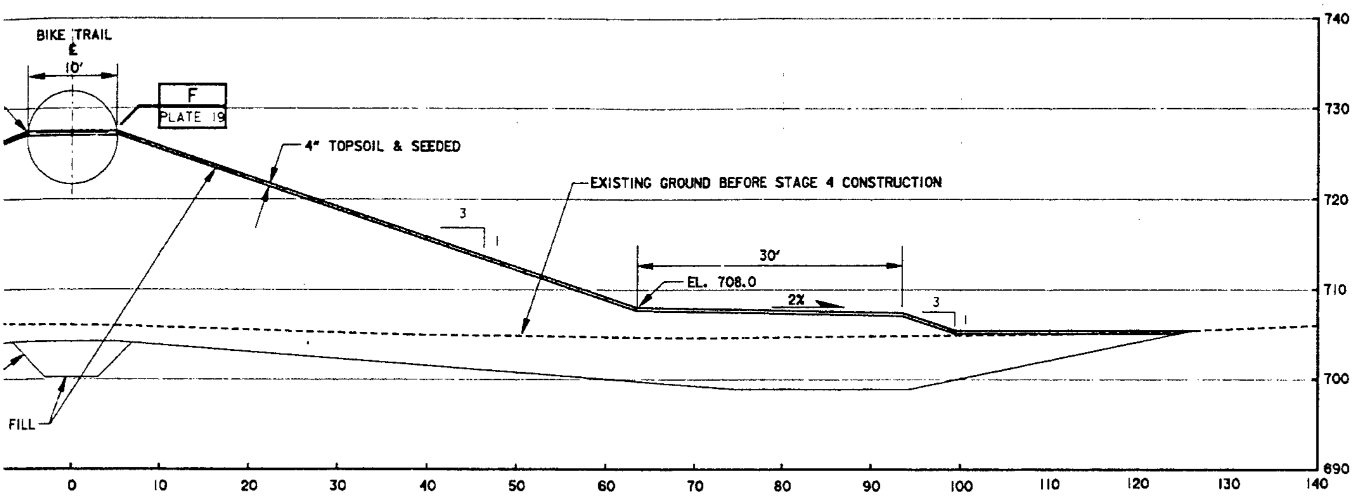


TYPICAL SECTION

OUTLET E ALIGNMENT

SCALE: AS SHOWN

1

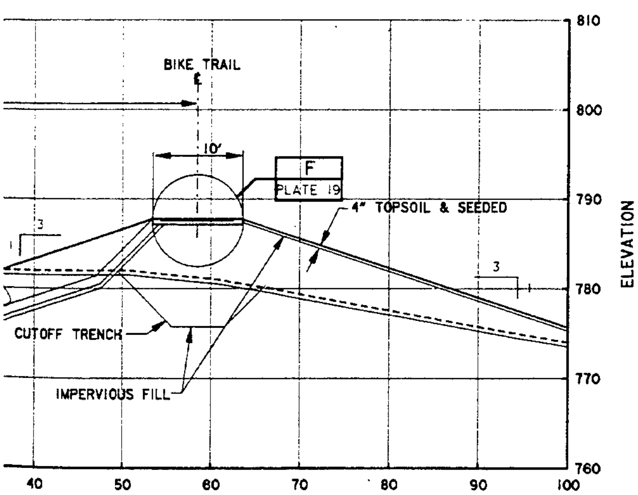


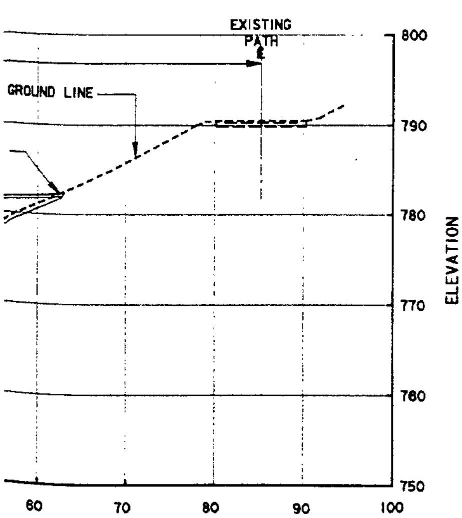
IL SECTION

ET D LEVEE

N

A





NOTES:

1. ELEVATIONS VARY, SEE PROFILE ON PLATE 8
2. ALL ELEVATIONS SHOWN ARE MSL 1929 ADJ.
3. SEE DETAIL H PLATE 19 FOR LANDSCAPE OVERBUILD.

REFERENCES:

		PLATE NO.
1.	LOCATION MAP, VICINITY MAP, & DRAWING INDEX	1
2.	GENERAL PLAN	2
3.	PLAN AND PROFILE STA. 50+00 TO 60+00	8
4.	MISCELLANEOUS DETAILS	19
5.	OUTLET E PROFILE	31

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY

ST. PAUL DISTRICT, CORPS OF ENGINEERS

ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

DESIGN MEMORANDUM

CHASKA - STAGE 3

EAST CREEK

CHASKA PROJECT FLOOD CONTROL CHASKA, MINNESOTA

TYPICAL SECTIONS

STA. 58+70 TO STA. 58+80

ED-D	DESIGNED:	MB
	CHECKED:	CA
	DRAWN:	T.J.
ED-CH	DESIGNED:	
	CHECKED:	
DATE:		12-10-93

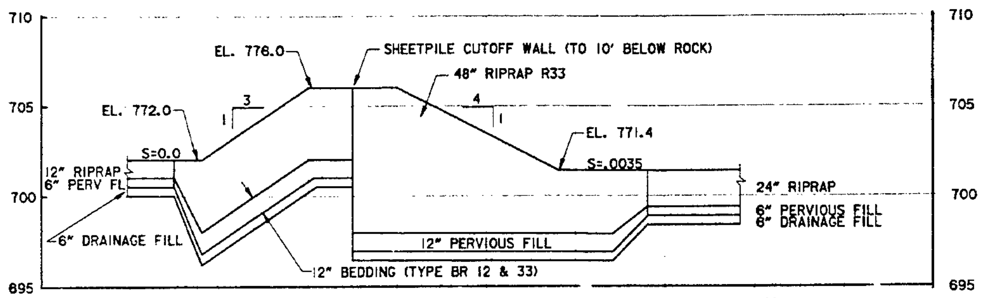
CAD FILE NAME: NC05P018.DGN

SPEC NO:

DRAWING NUMBER: PLATE 18

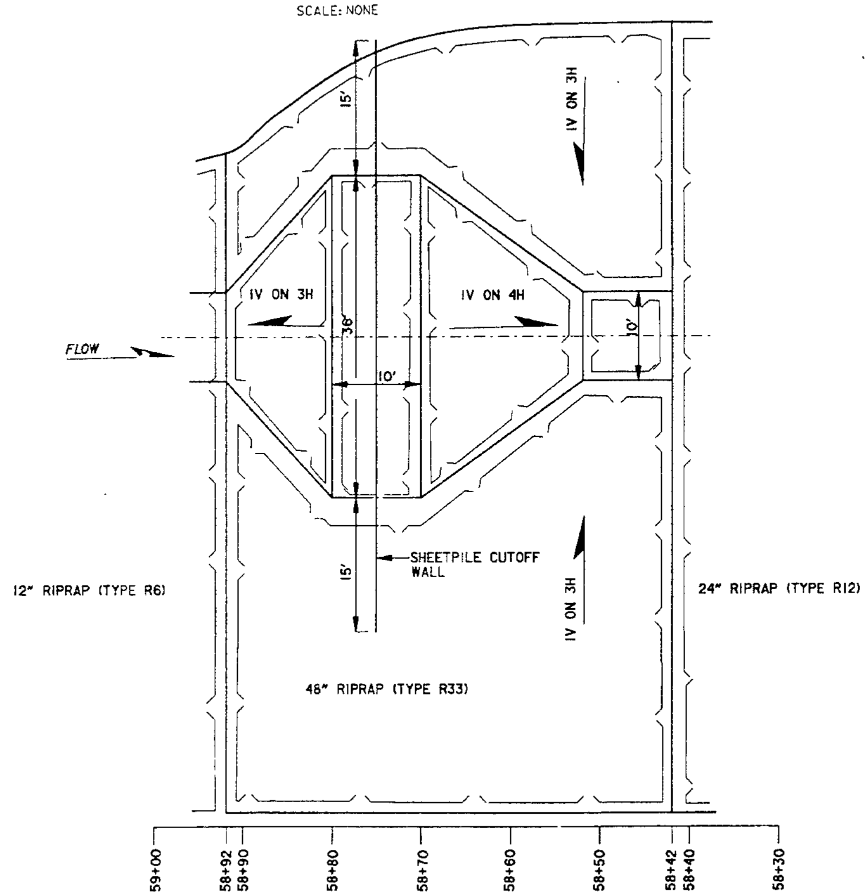
SHT 18 OF 43

(2)



OVERFLOW STRUCTURE PROFILE

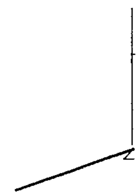
SCALE: NONE



PLAN VIEW

DETAIL	A
OVERFLOW STRUCTURE	PLATE 8

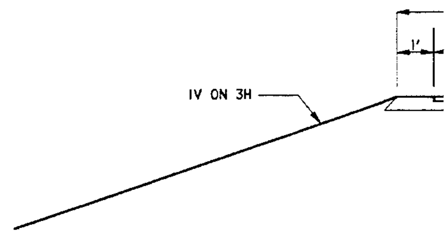
SCALE: NONE



DETAIL

ACCESS ROA

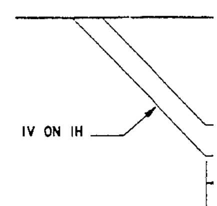
SCALE: NONE



DETAIL

BIKE TRAIL

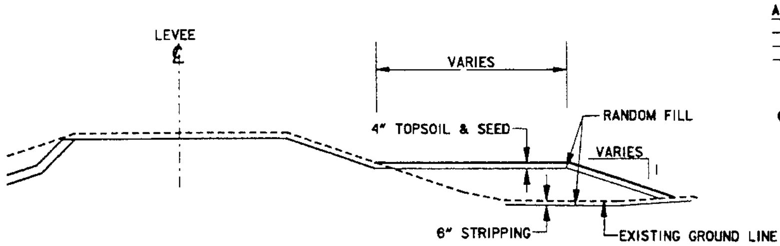
SCALE: NONE



DETAIL

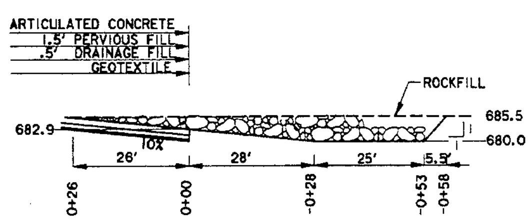
TYPICAL END

SCALE: NONE



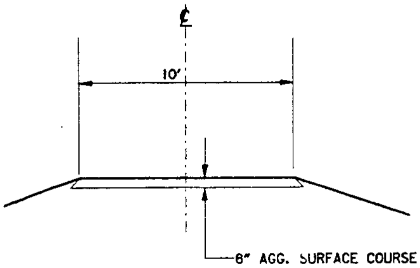
DETAIL	H
LANDSCAPE TOP OVERBUILD	

SCALE: NONE

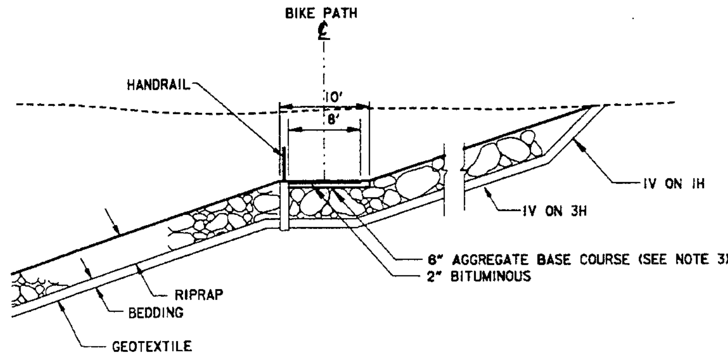


SECTION	L
ROCKFILL END DETAIL	PLATE 3

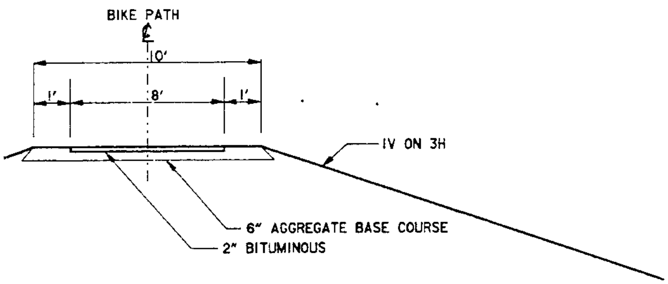
SCALE: NONE



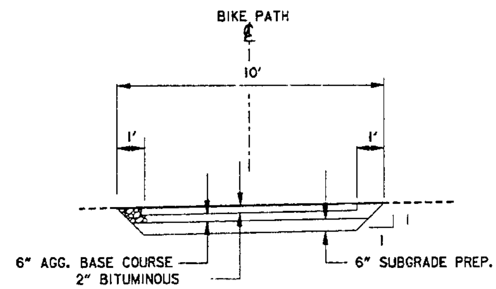
'AIL
ESS ROAD ON LEVEE
E: NONE
D



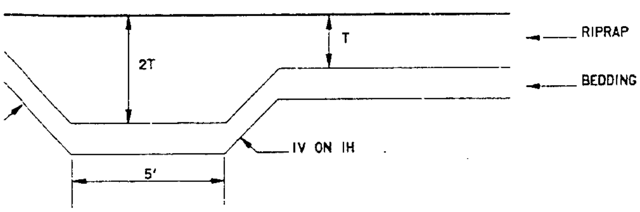
DETAIL
BIKE TRAIL ON RIPRAP
SCALE: NONE
C



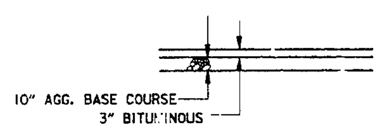
'AIL
TRAIL ON LEVEE
E: NONE
F



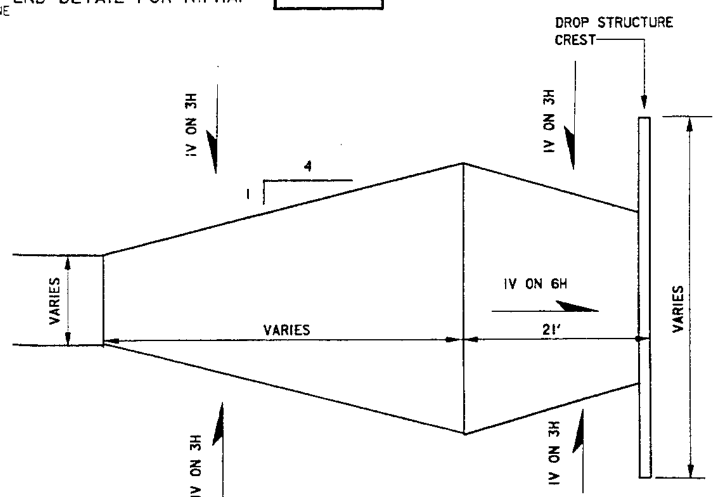
DETAIL
BIKE TRAIL ON EXISTING GROUND
SCALE: NONE
E



AIL
CAL END DETAIL FOR RIPRAP
NONE
G



DETAIL
PARKING LOT
SCALE: NONE
J



DETAIL
TYPICAL PLAN VIEW DETAIL FOR SAFETY RAMPS UPSTREAM OF DROP STRUCTURES
SCALE: NONE
K

NOTES:

1. ELEVATIONS VARY - SEE PROFILE
2. ALL ELEVATIONS SHOWN ARE MSL 1929 ADJ.
3. CHINK RIPRAP WITH BEDDING WHERE BASE COURSE IS PLACED DIRECTLY ADJACENT TO RIPRAP

REFERENCES:	PLATE NO.
1. LOCATION MAP, VICINITY MAP, & DRAWING INDEX	1
2. GENERAL PLAN	2

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

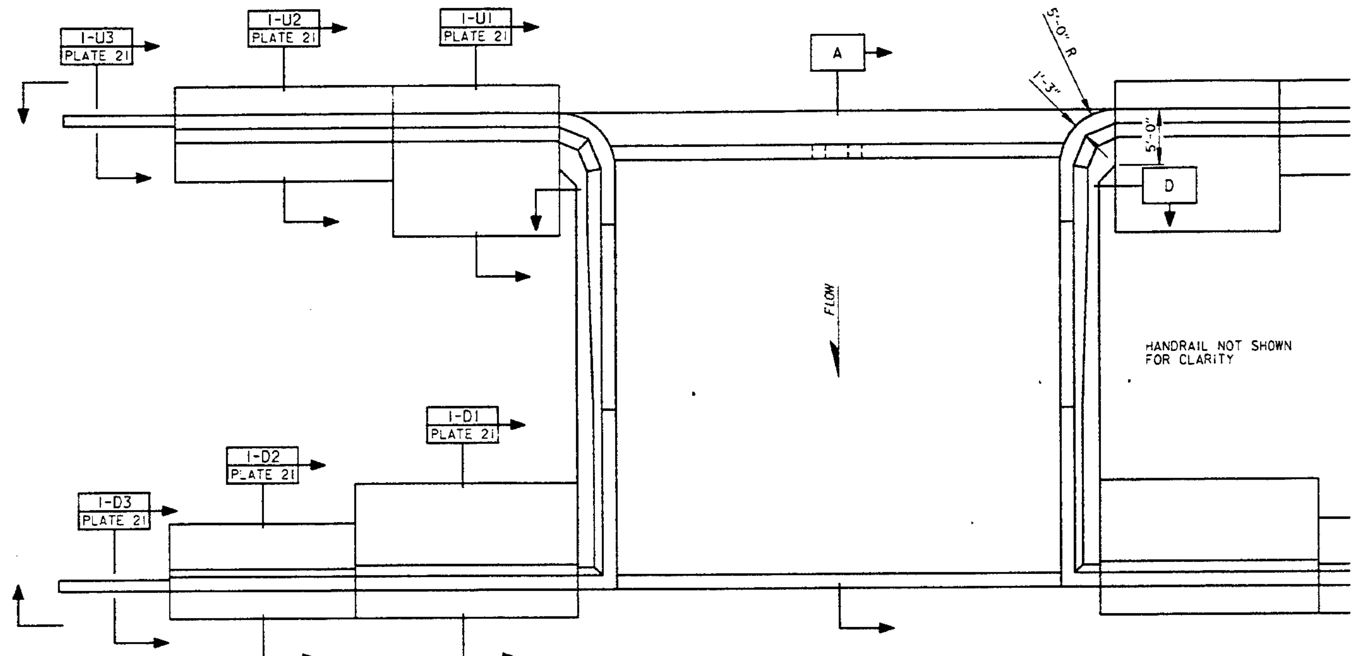
AE APPROVING OFFICIAL:

DESIGN MEMORANDUM
CHASKA - STAGE 3
EAST CREEK
CHASKA PROJECT — CHASKA, MINNESOTA
FLOOD CONTROL
MISC. DETAILS

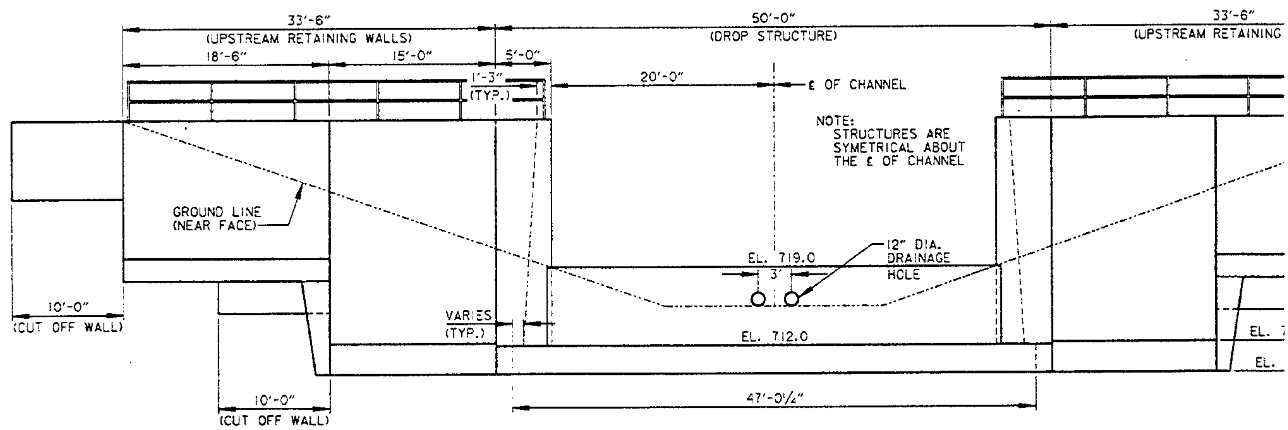
ED-D	DESIGNED:	MB
	CHECKED:	CC
	DRAWN:	T.J.
ED-GH	DESIGNED:	
	CHECKED:	

DATE: 12/10/93
CAD FILE NAME: NCO5PO19.DGN
SPEC NO: DACW37
DRAWING NUMBER: PLATE 19
SHT 19 OF 43

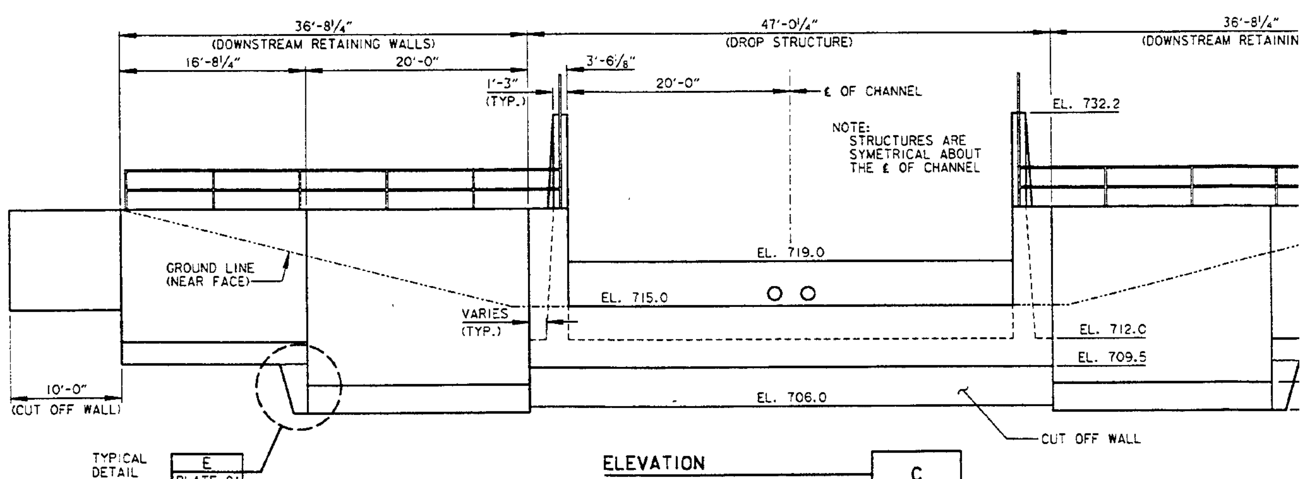
2



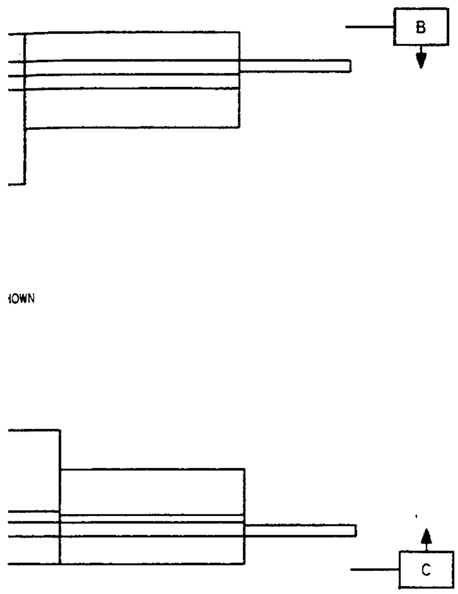
PLAN
DROP STRUCTURE I
SCALE: 1/8" = 1'-0"

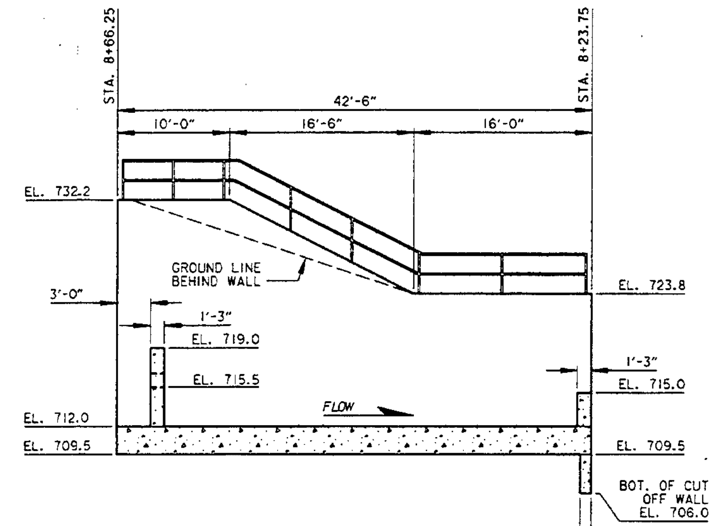


ELEVATION
DROP STRUCTURE AND
UPSTREAM RETAINING WALLS
SCALE: 1/8"=1'-0"
B



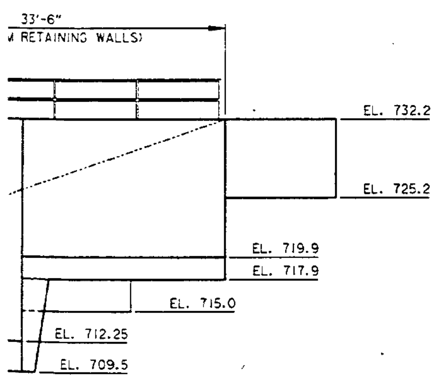
ELEVATION
DROP STRUCTURE AND
DOWNSTREAM RETAINING WALLS
SCALE: 1/8"=1'-0"
C

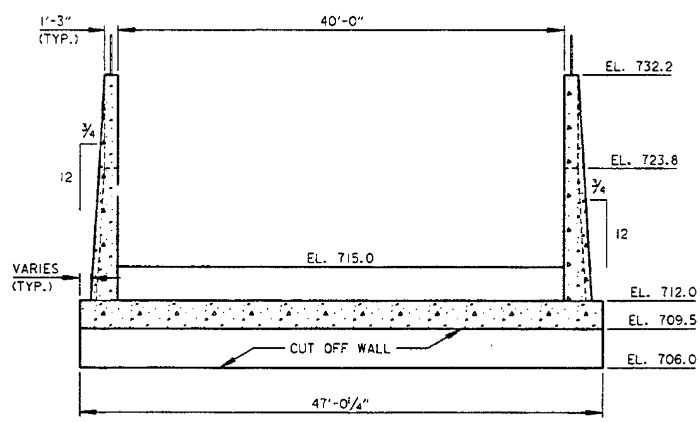




PROFILE
DROP STRUCTURE 1
SCALE: 1/8"=1'-0"

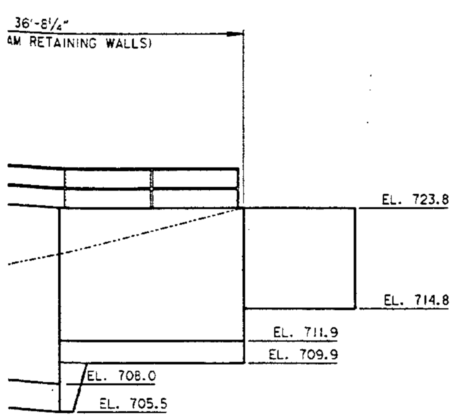
A

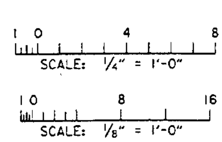




SECTION
DROP STRUCTURE 1
SCALE: 1/8"=1'-0"

D



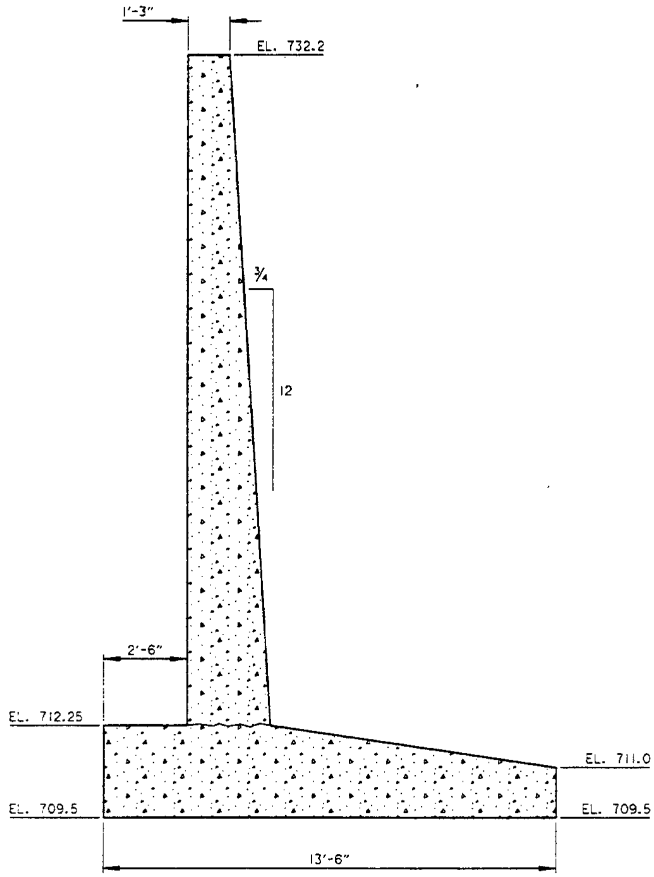


SYMBOL	DESCRIPTION	DATE	APPROVAL

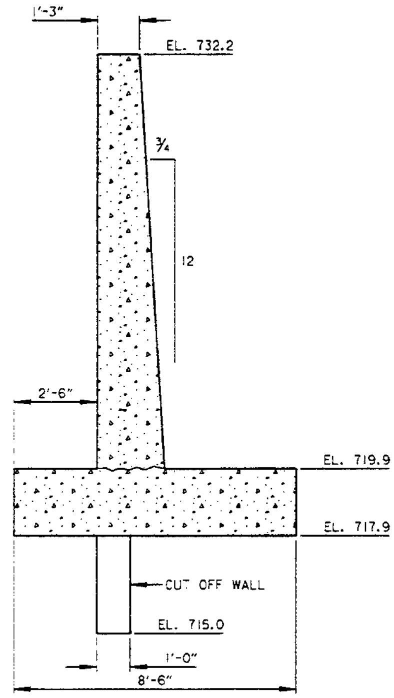
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:	DESIGN MEMORANDUM CHASKA STAGE 3 FLOOD CONTROL - EAST CREEK CHASKA PROJECT CHASKA, MINNESOTA FLOOD CONTROL DROP STRUCTURE 1 & RETAINING WALLS PLAN, PROFILE, ELEVATIONS & SECTION
ED-D DESIGNED: JHM	
CHECKED: KDH	
DRAWN: LKT	
ED-GH DESIGNED: XXX/XXX	
CHECKED:	CAD FILE NAME: NCSPRD1A.DGN · DRAWING NUMBER: PLATE 20 · SHT 20 OF 43
DATE: 09-15-93	SPEC NO:

(9)

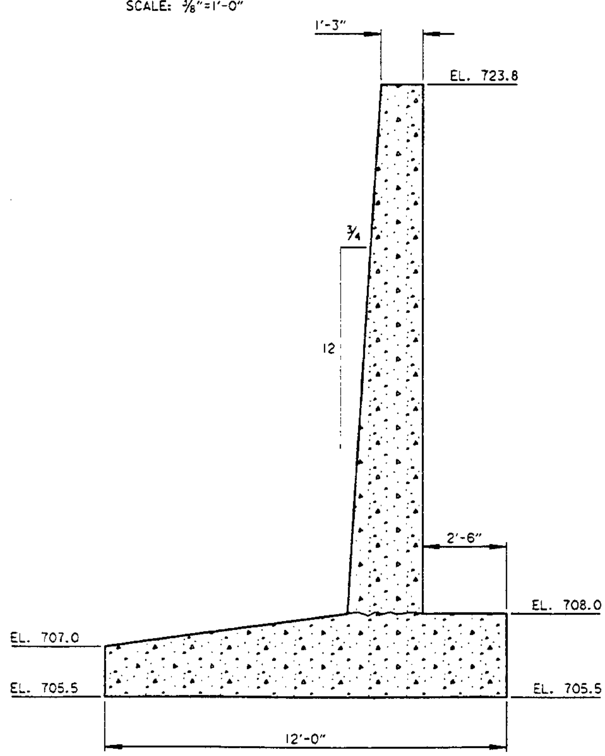


SECTION 1-U1
UPSTREAM RETAINING WALL PLATE 20
SCALE: ⅜"=1'-0"

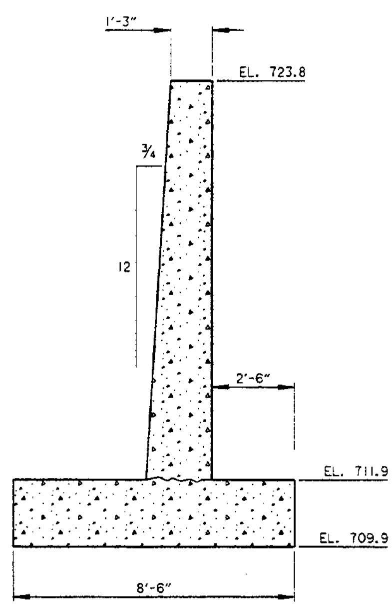


SECTION 1-U2
UPSTREAM RETAINING WALL PLATE 20
SCALE: ⅜"=1'-0"

SECTI
UPSTRE
SCALE:

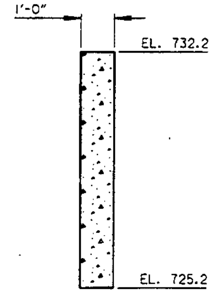


SECTION 1-D1
DOWNSTREAM RETAINING WALL PLATE 20
SCALE: ⅜"=1'-0"

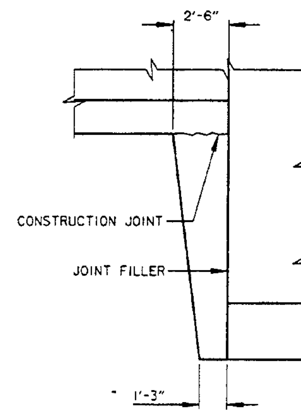


SECTION 1-D2
DOWNSTREAM RETAINING WALL PLATE 20
SCALE: ⅜"=1'-0"

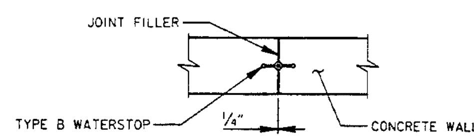
SECTI
DOWNS
SCALE:



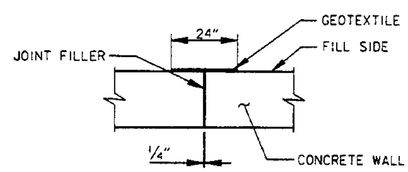
SECTION | I-U3
UPSTREAM CUT OFF WALL | PLATE 20
SCALE: 3/8"=1'-0"



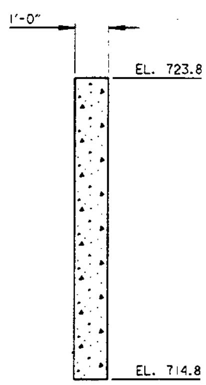
TYPICAL DETAIL | E
PLATE 20
PLATE 23
PLATE 26
PLATE 29
SCALE: 1/4"=1'-0"



TYPICAL U/S VERTICAL JOINT DETAIL
SCALE: 1/2" = 1'-0"



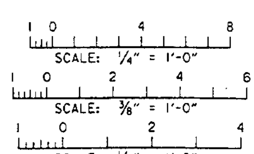
TYPICAL D/S VERTICAL JOINT DETAIL
SCALE: 1/2" = 1'-0"



SECTION | I-D3
DOWNSTREAM CUT OFF WALL | PLATE 20
SCALE: 3/8"=1'-0"

NOTE:

1. HANDRAIL NOT SHOWN FOR CLARITY.



SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

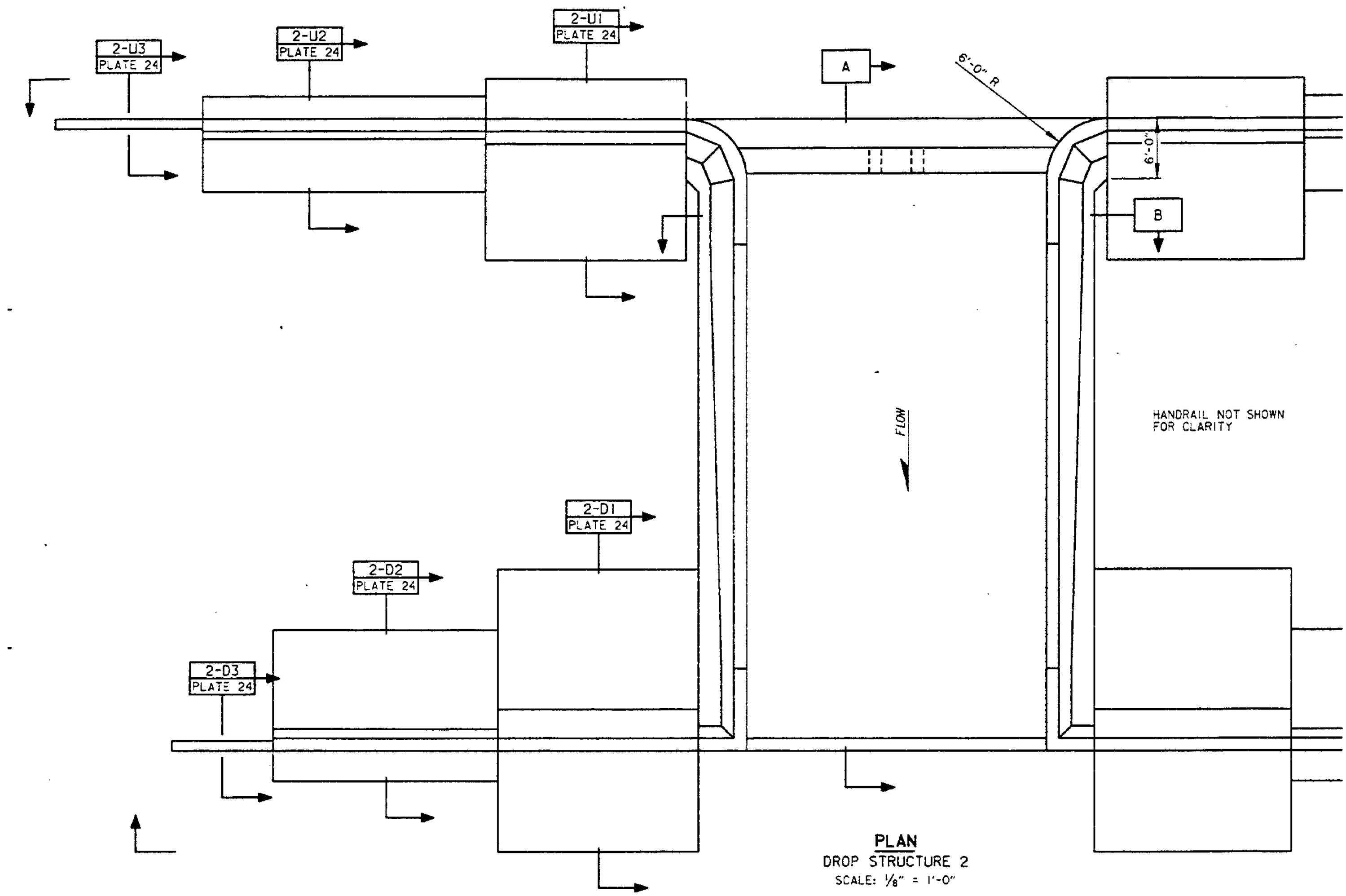
AE APPROVING OFFICIAL:

ED-D: DESIGNED: JHM / CHECKED: KOH / DRAWN: LKT
ED-GH: DESIGNED: XXX/XXX / CHECKED:
DATE: 11-02-93

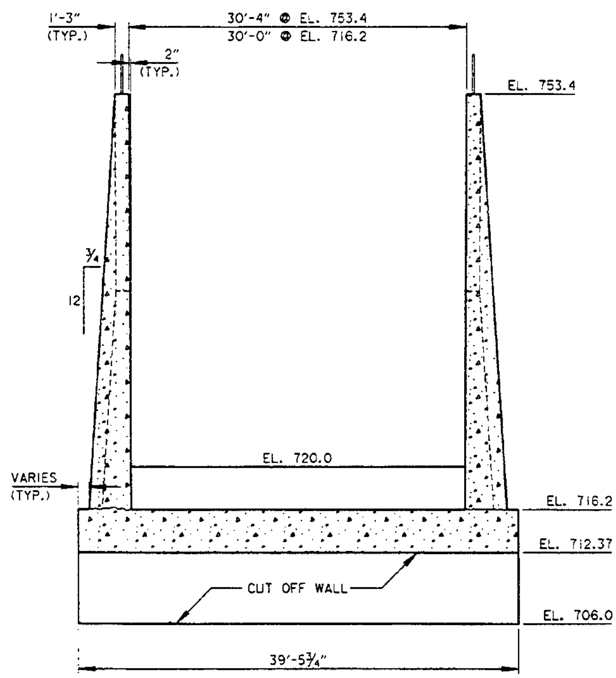
DESIGN MEMORANDUM
CHASKA STAGE 3
FLOOD CONTROL - EAST CREEK
CHASKA PROJECT CHASKA, MINNESOTA
FLOOD CONTROL
DROP STRUCTURE I RETAINING & CUT OFF WALLS
SECTIONS & TYPICAL DETAILS

CAD FILE NAME: NCSPRD1B.DGN
SPEC NO:
DRAWING NUMBER: **PLATE 21**
SHT 21 OF 43

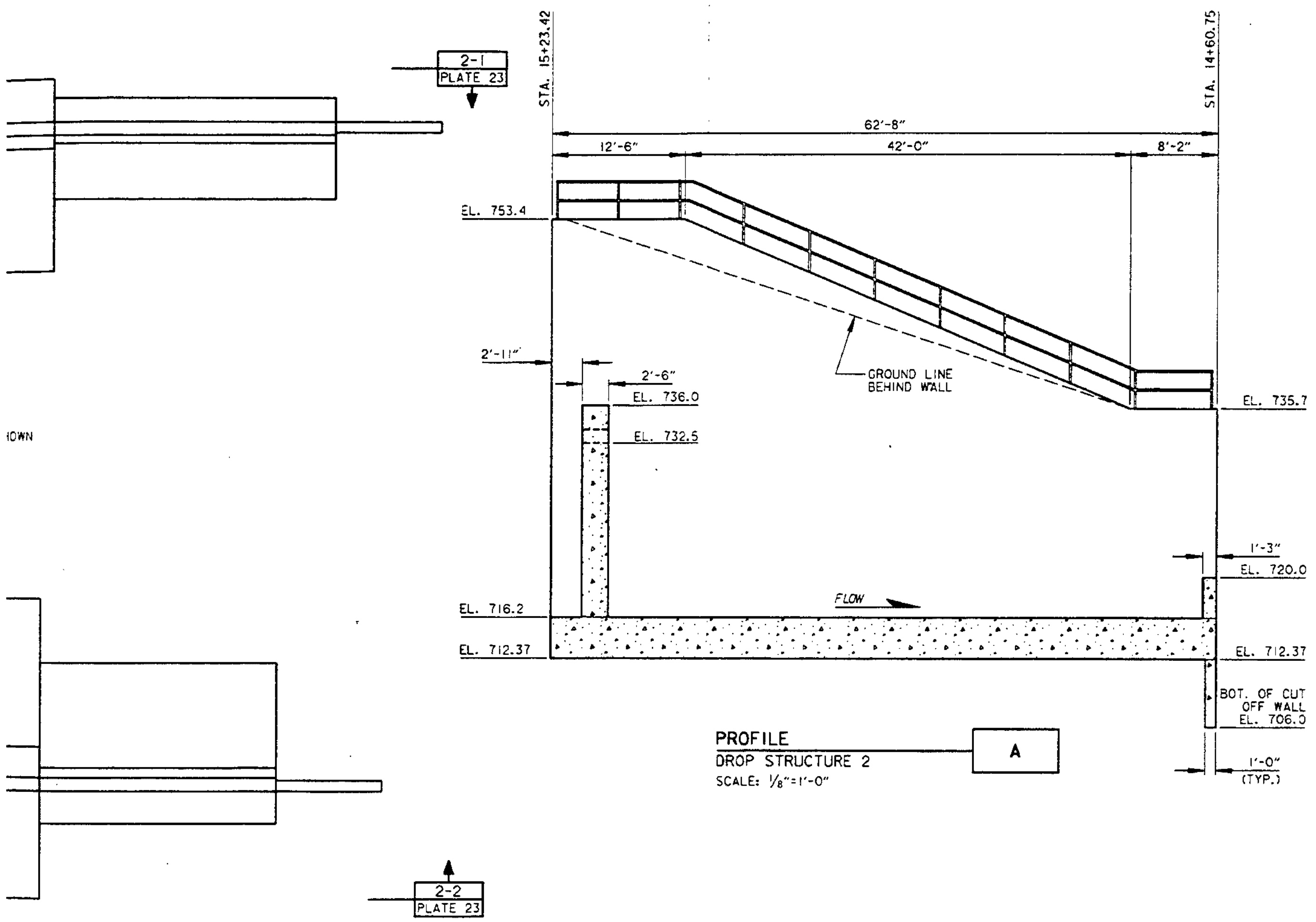
8



PLAN
DROP STRUCTURE 2
SCALE: 1/8" = 1'-0"



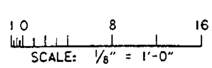
SECTION B
DROP STRUCTURE 2
SCALE: 1/8"=1'-0"



PROFILE
DROP STRUCTURE 2
SCALE: 1/8"=1'-0"

REFERENCES: DWG. NO.

TYPICAL JOINT DETAILS ---------------------------------- PLATE 21



SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

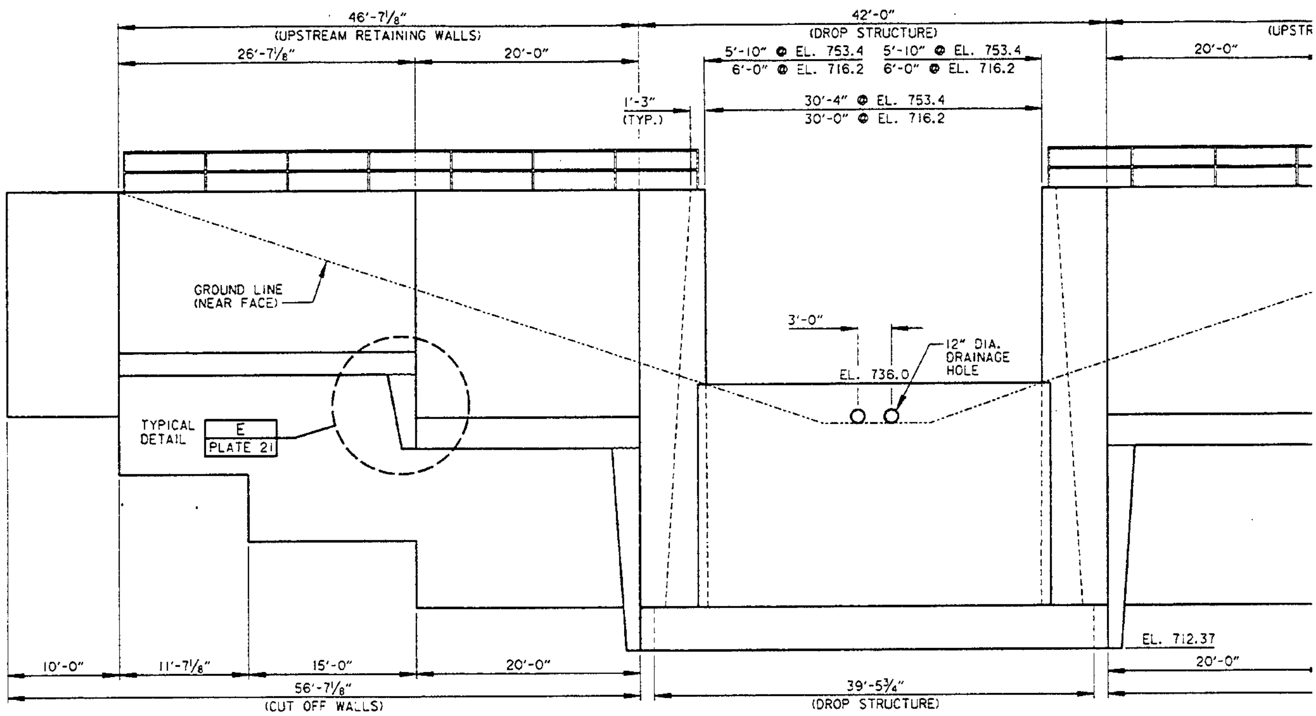
AE APPROVING OFFICIAL:

DESIGN MEMORANDUM
CHASKA STAGE 3
FLOOD CONTROL - EAST CREEK
CHASKA PROJECT CHASKA, MINNESOTA
FLOOD CONTROL
DROP STRUCTURE 2
PLAN, PROFILE & SECTION

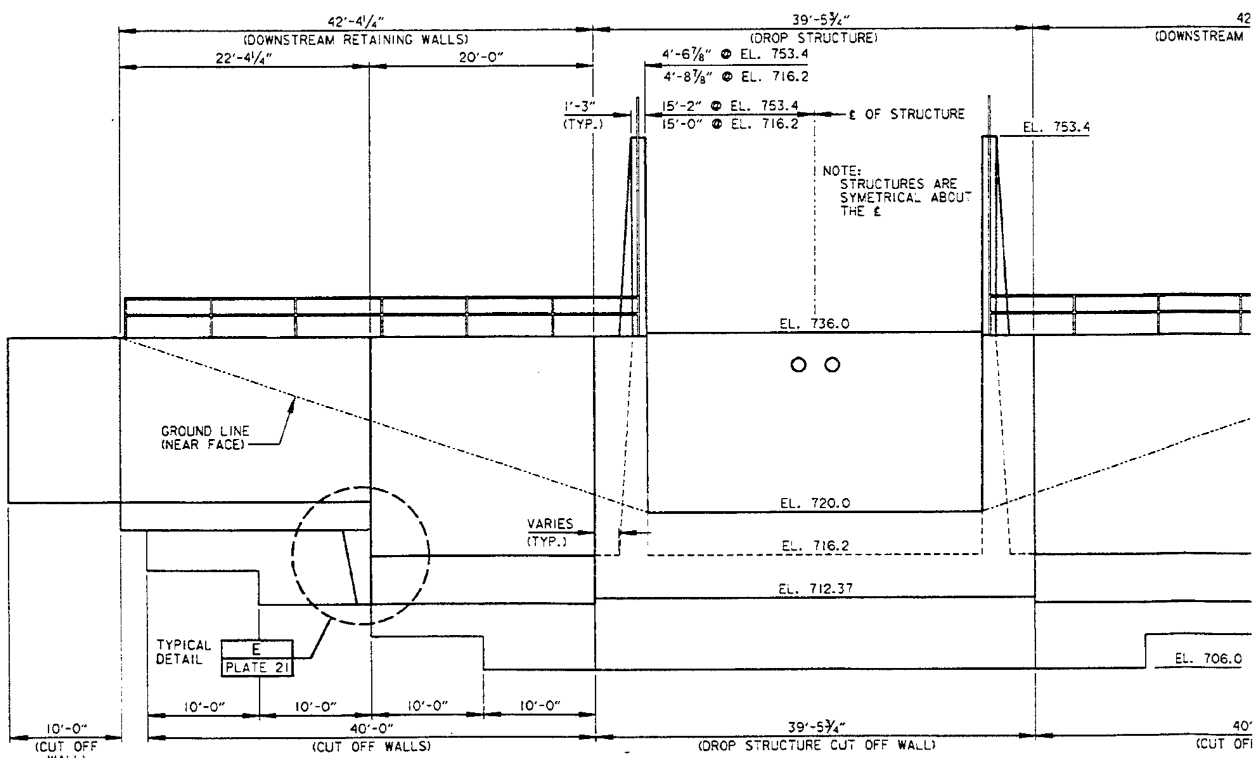
ED-D DESIGNED: JHM
CHECKED: KDH
DRAWN: LKT
ED-GH DESIGNED: XXX/XXX
CHECKED:
DATE: 11-02-93

CAD FILE NAME: NCSPRD2A.DGN
SPEC NO:
DRAWING NUMBER: PLATE 22
SHT 22 OF 43

9

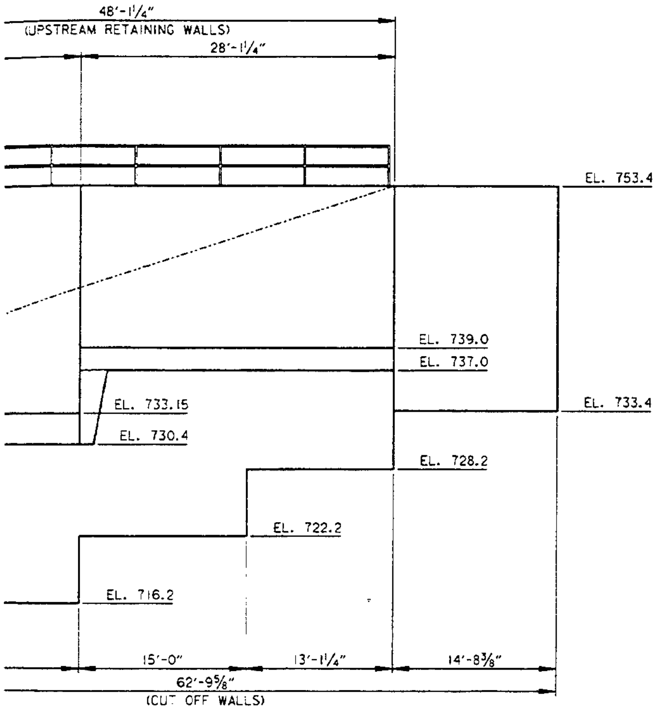


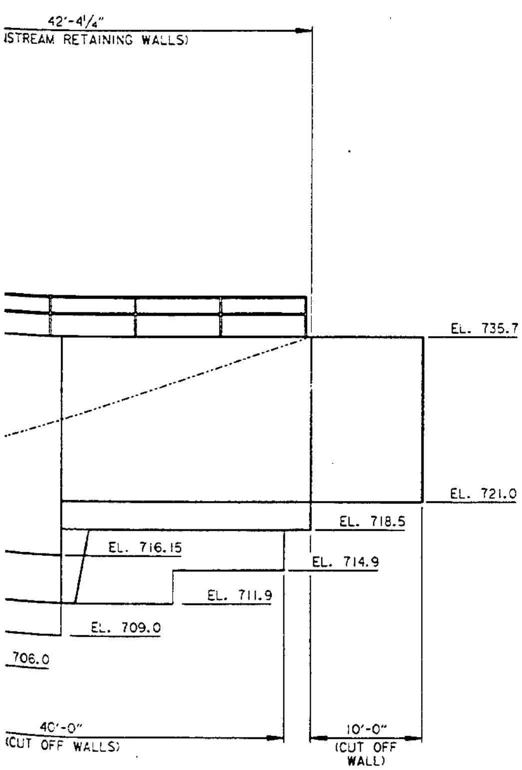
ELEVATION 2-1 PLATE 22
DROP STRUCTURE AND UPSTREAM RETAINING WALLS
SCALE: 1/8"=1'-0"



ELEVATION 2-2 PLATE 22
DROP STRUCTURE AND DOWNSTREAM RETAINING WALLS
SCALE: 1/8"=1'-0"

(1)





10 8 16
SCALE: ⅛" = 1'-0"

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

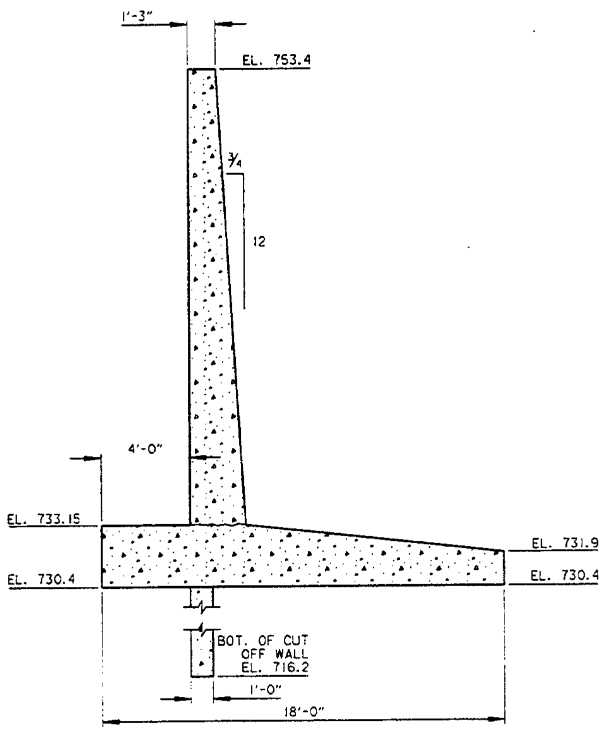
AE APPROVING OFFICIAL:

DESIGN MEMORANDUM
CHASKA STAGE 3
FLOOD CONTROL - EAST CREEK
CHASKA PROJECT CHASKA, MINNESOTA
FLOOD CONTROL
DROP STRUCTURE 2 & RETAINING WALLS
ELEVATIONS

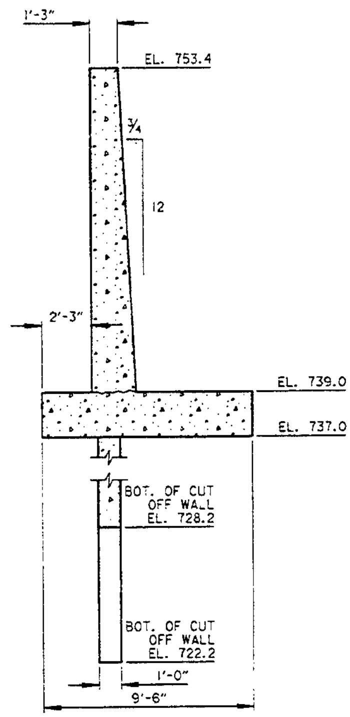
ED-D	DESIGNED:	JHM
	CHECKED:	KDH
	DRAWN:	LKT
ED-GH	DESIGNED:	XXX/XXX
	CHECKED:	
DATE: 12-13-93		

CAD FILE NAME: NCSPRD28.DGN
SPEC NO:
DRAWING NUMBER: PLATE 23
SHT 23 OF 43

(2)

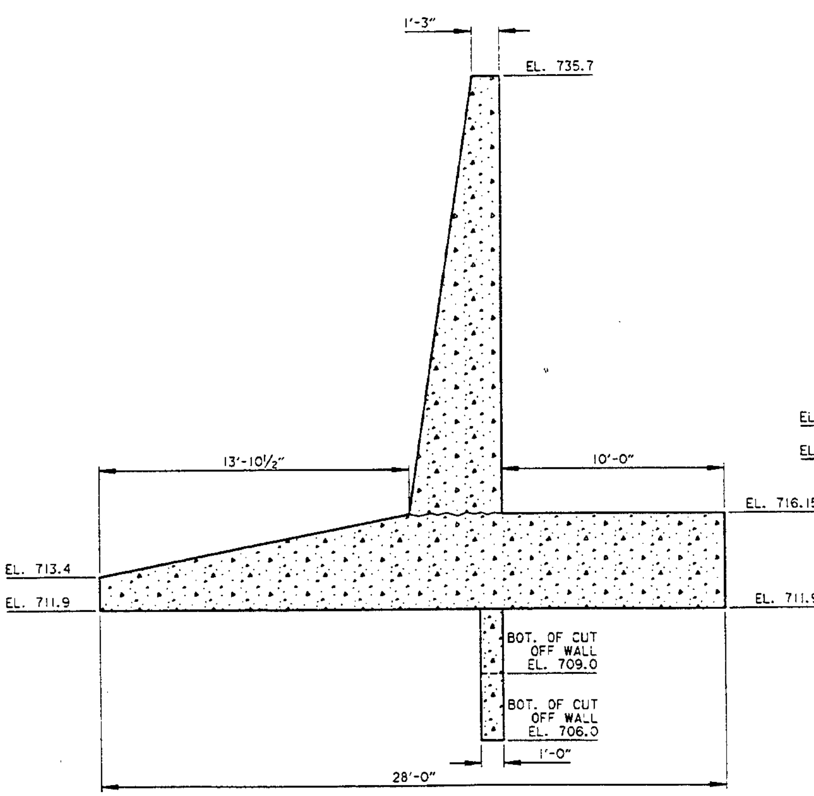


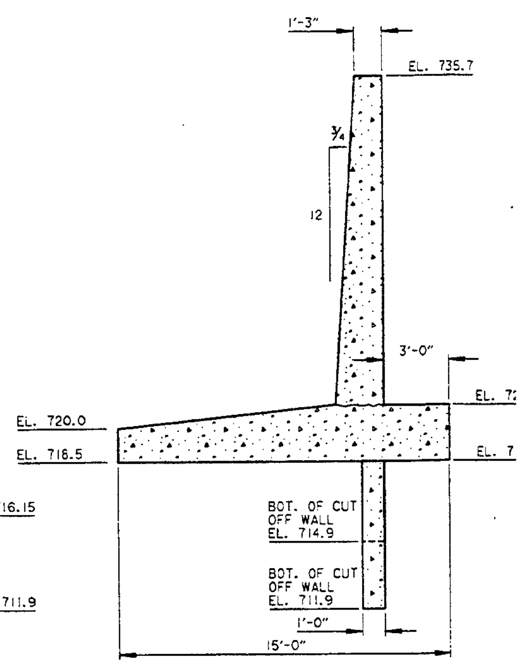
SECTION 2-U1
UPSTREAM RETAINING WALL PLATE 22
SCALE: 1/4"=1'-0"



SECTION 2-U2
UPSTREAM RETAINING WALL PLATE 22
SCALE: 1/4"=1'-0"

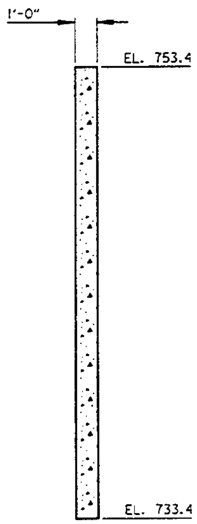
SECTIO
UPSTRE
SCALE: 1/



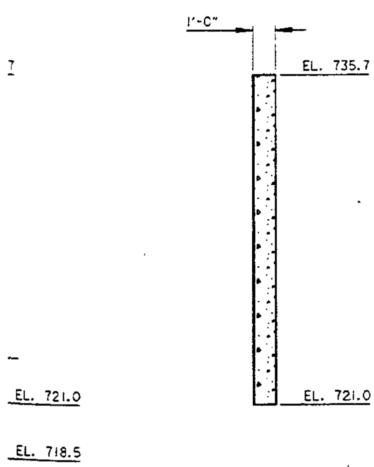


SECTION 2-D2
DOWNSTREAM RETAINING WALL PLATE 22
SCALE: 1/4"=1'-0"

SECTION 2-D1
DOWNSTREAM RETAINING WALL PLATE 22
SCALE: 1/4"=1'-0"



ECTION — 2-U3
ᴾSTREAM CUT OFF WALL — PLATE 22
ᶜALE: 1/4"=1'-0"



SECTION — 2-D3
DOWNSTREAM CUT OFF WALL — PLATE 22
SCALE: 1/4"=1'-0"

NOTE:

1. HANDRAIL NOT SHOWN FOR CLARITY.

0 4 8
SCALE: 1/4" = 1'-0"

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

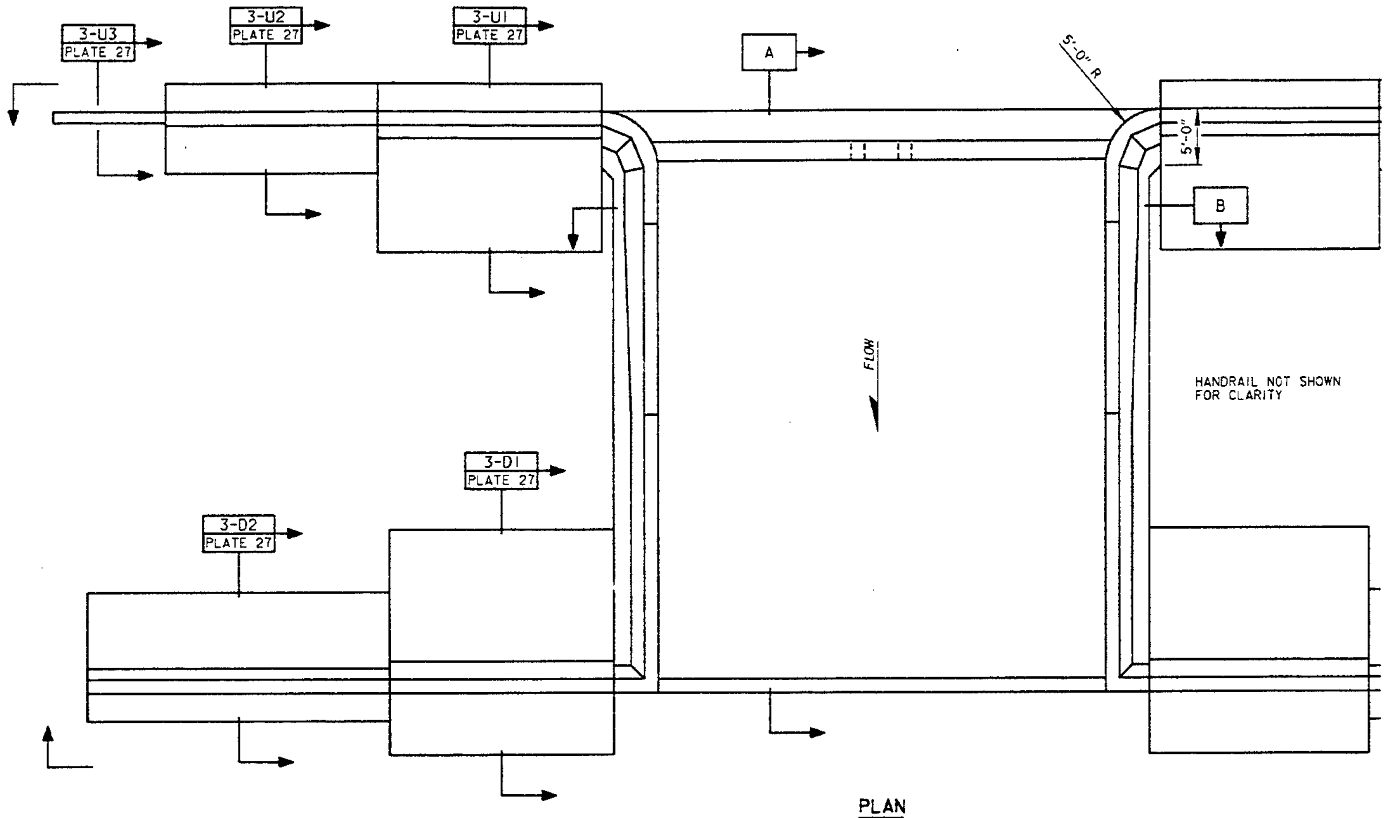
AE APPROVING OFFICIAL:

ED-D	DESIGNED: JHM
	CHECKED: KDH
	DRAWN: LKT
ED-GH	DESIGNED: XXX/XXX
	CHECKED:
DATE: 11-02-93	

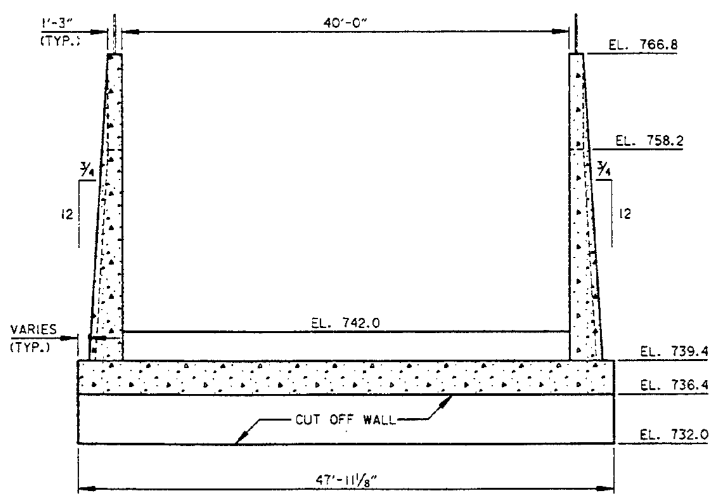
DESIGN MEMORANDUM
CHASKA STAGE 3
FLOOD CONTROL - EAST CREEK
CHASKA PROJECT — CHASKA, MINNESOTA
FLOOD CONTROL
DROP STRUCTURE 2 RETAINING & CUT OFF WALLS
SECTIONS

CAD FILE NAME: NCSPRD2C.DGN
SPEC NO:
DRAWING NUMBER: PLATE 24
SHT 24 OF 43

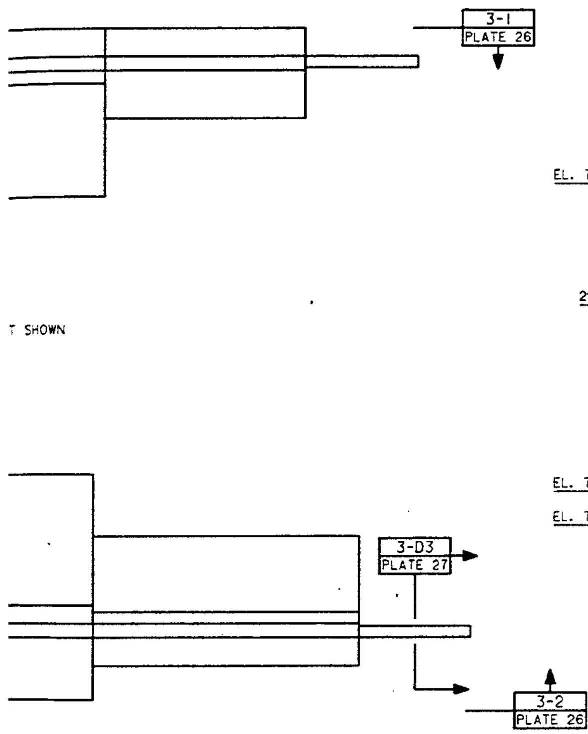
(2)

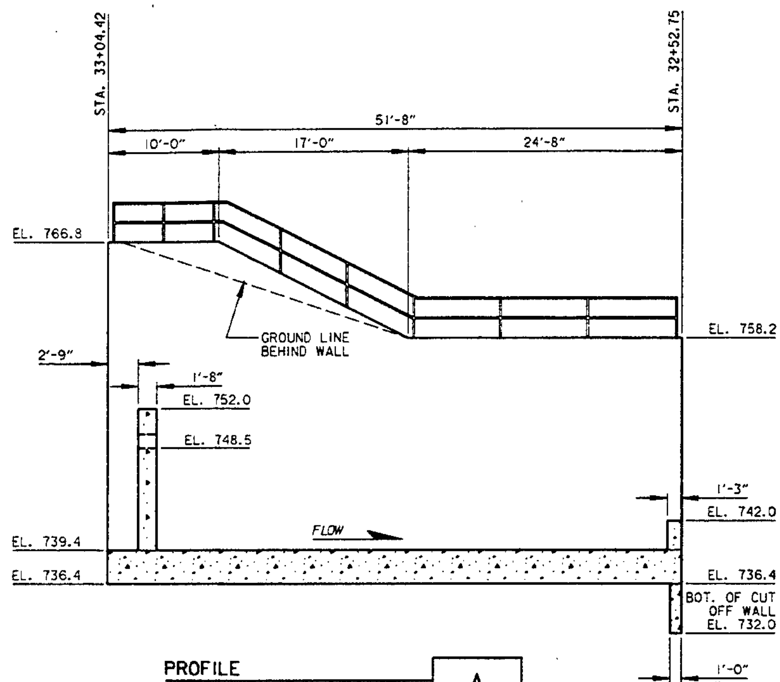


PLAN
DROP STRUCTURE 3
SCALE: 1/8" = 1'-0"



SECTION
DROP STRUCTURE 3
SCALE: 1/8"=1'-0"
B





PROFILE
DROP STRUCTURE 3
SCALE: 1/8"=1'-0"

REFERENCES: DWG. NO.

TYPICAL JOINT DETAILS ---------------------------------- PLATE 21

SCALE: 1/8" = 1'-0"

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

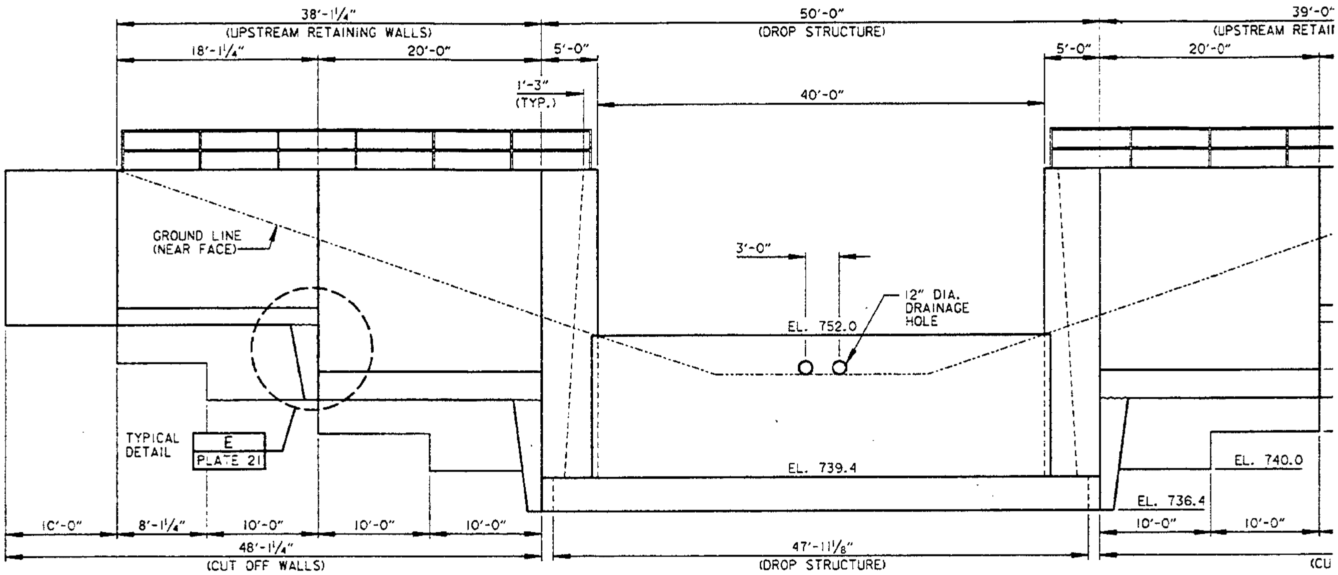
AE APPROVING OFFICIAL:

DESIGN MEMORANDUM
CHASKA STAGE 3
FLOOD CONTROL - EAST CREEK
CHASKA PROJECT CHASKA, MINNESOTA
FLOOD CONTROL
DROP STRUCTURE 3
PLAN, PROFILE & SECTION

ED-D	DESIGNED:	JHM
ED-D	CHECKED:	KDH
ED-D	DRAWN:	LKT
ED-GH	DESIGNED:	XXX/XXX
ED-GH	CHECKED:	
DATE:	11-02-93	

CAD FILE NAME: NCSPRD3A.DGN
SPEC NO:
DRAWING NUMBER: PLATE 25
SHT 25 OF 43

3

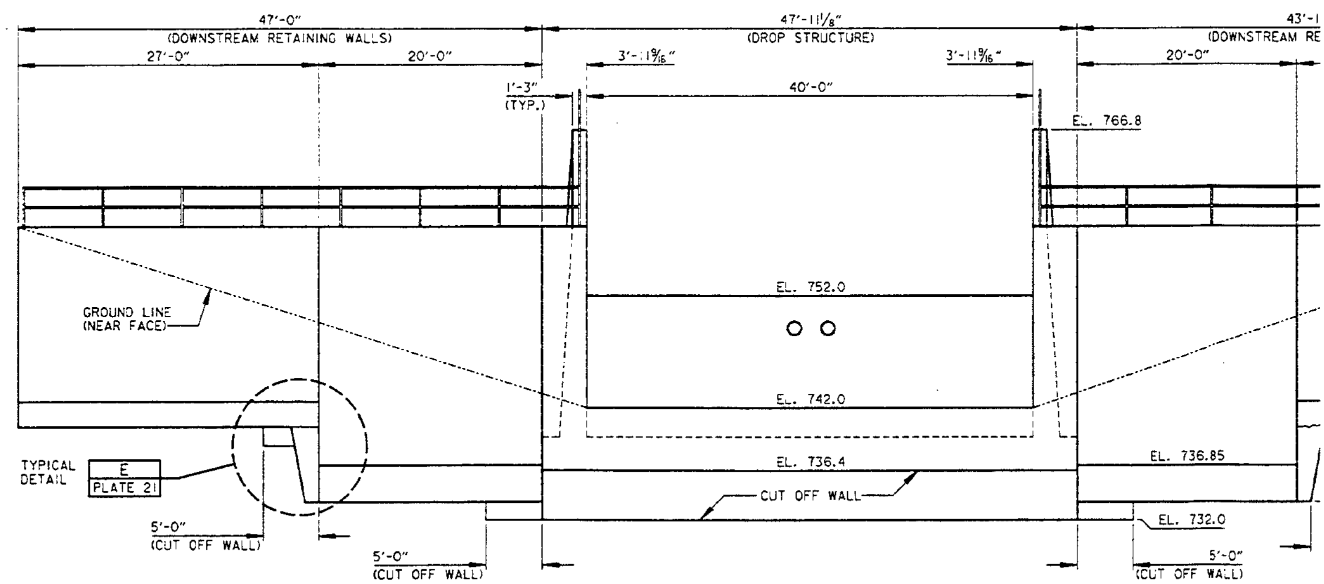


ELEVATION

DROP STRUCTURE AND
UPSTREAM RETAINING WALLS

SCALE: ⅛"=1'-0"

3-1
PLATE 25



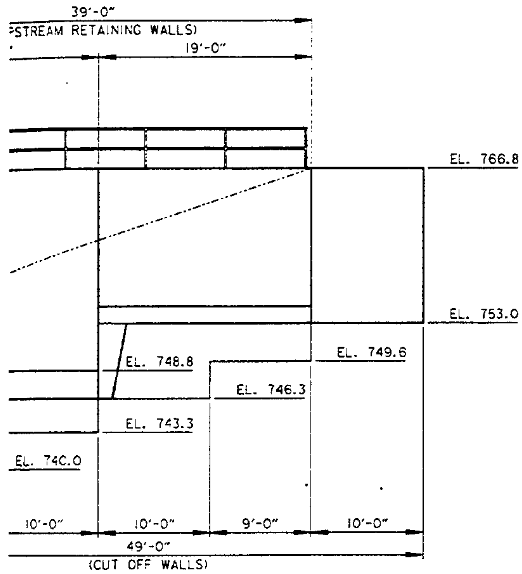
ELEVATION

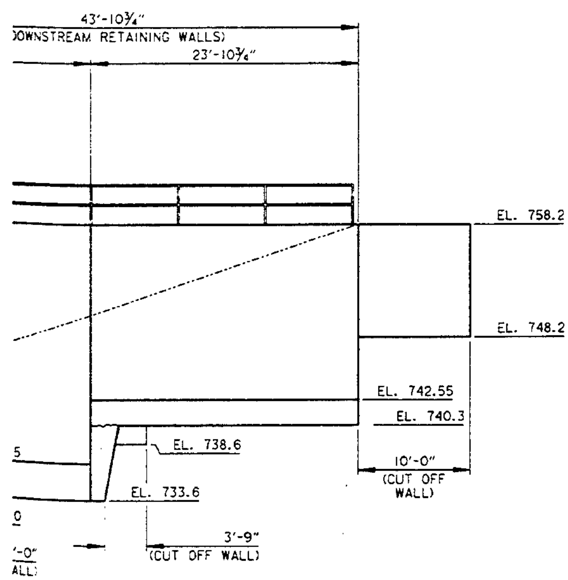
DROP STRUCTURE AND
DOWNSTREAM RETAINING WALLS

SCALE: ⅛"=1'-0"

3-2
PLATE 25

(1)





SCALE: 1/8" = 1'-0"

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

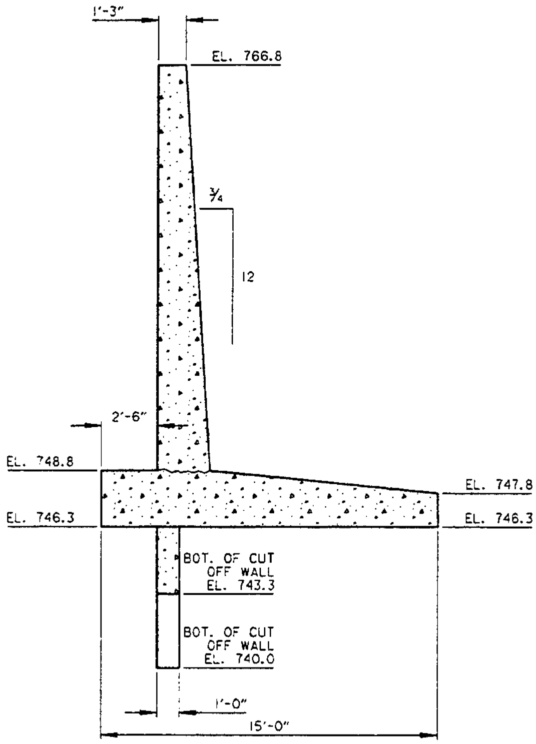
AE APPROVING OFFICIAL:

DESIGN MEMORANDUM
CHASKA STAGE 3
FLOOD CONTROL - EAST CREEK
CHASKA PROJECT CHASKA, MINNESOTA
FLOOD CONTROL
DROP STRUCTURE 3 & RETAINING WALLS
ELEVATIONS

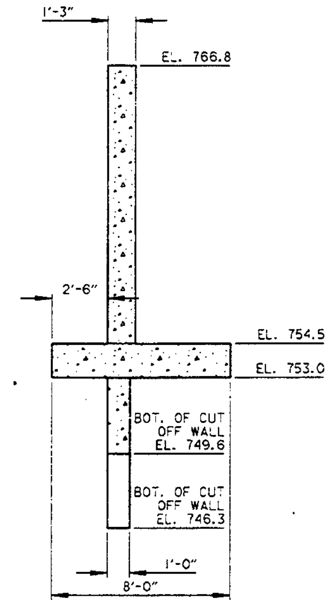
ED-D: DESIGNED: JHM; CHECKED: KDH; DRAWN: LKT
ED-GH: DESIGNED: XXX/XXX; CHECKED:
DATE: 12-13-93

CAD FILE NAME: NCSPRD3B.DGN
SPEC NO:
DRAWING NUMBER: PLATE 26
SHT 26 OF 43

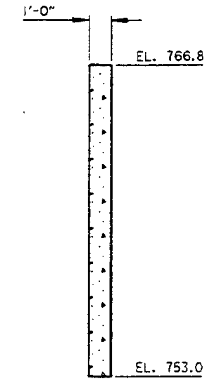
2



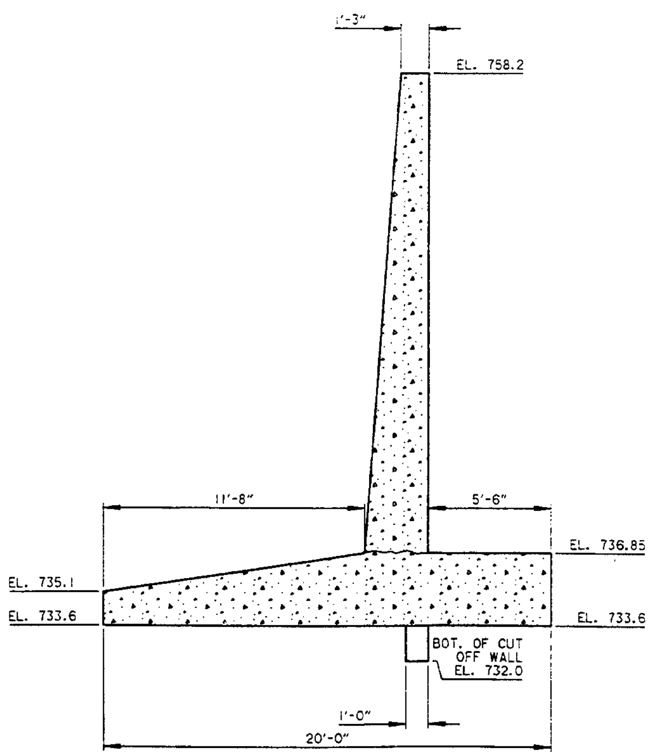
SECTION | 3-U1
UPSTREAM RETAINING WALL | PLATE 25
SCALE: ¼"=1'-0"



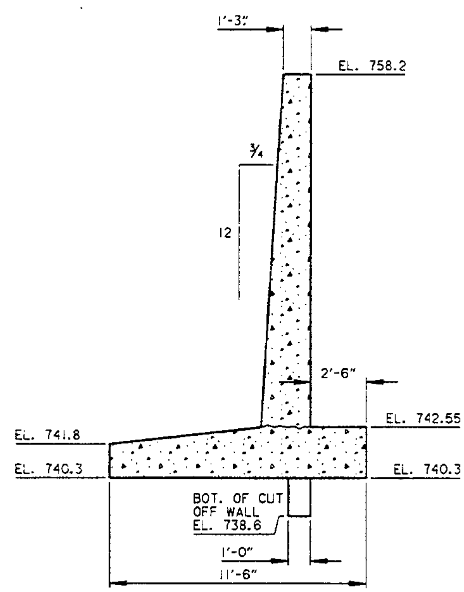
SECTION | 3-U2
UPSTREAM RETAINING WALL | PLATE 25
SCALE: ¼"=1'-0"



SECTION
UPSTREAM CUT OFF WALL
SCALE: ¼"=1'-0"



SECTION | 3-D1
DOWNSTREAM RETAINING WALL | PLATE 25
SCALE: ¼"=1'-0"



SECTION | 3-D2
DOWNSTREAM RETAINING WALL | PLATE 25
SCALE: ¼"=1'-0"

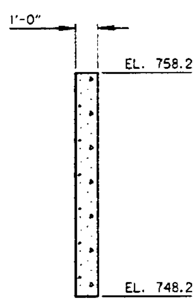
SECTI
DOWNST
SCALE:

(1)

766.8

753.0

3-U3
PLATE 25



NOTE:

1. HANDRAIL NOT SHOWN FOR CLARITY.

SECTION 3-D3
DOWNSTREAM CUT OFF WALL PLATE 25
SCALE: 1/4"=1'-0"

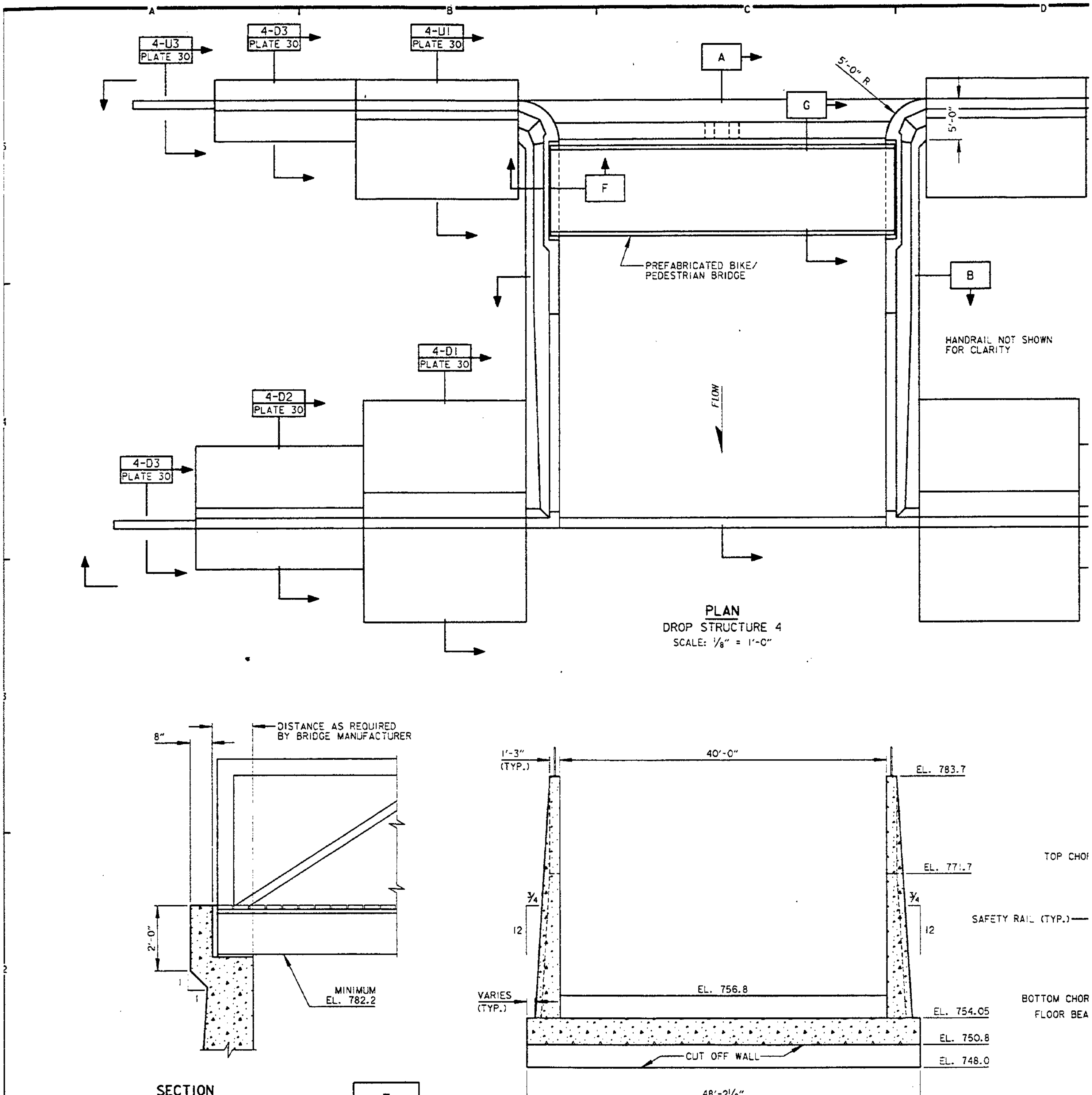
0 4 8
SCALE: 1/4" = 1'-0"

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:	DESIGN MEMORANDUM CHASKA STAGE 3 FLOOD CONTROL - EAST CREEK CHASKA PROJECT CHASKA, MINNESOTA FLOOD CONTROL DROP STRUCTURE 3 RETAINING & CUT OFF WALLS SECTIONS		
ED-D DESIGNED: JHM			
ED-D CHECKED: KOH			
ED-D DRAWN: LKT			
ED-GH DESIGNED: XXX/XXX			
ED-GH CHECKED:	CAD FILE NAME: NCSPRD3C.DGN	DRAWING NUMBER:	SHT 27
DATE: 09-08-93	SPEC NO:	PLATE 27	OF 43

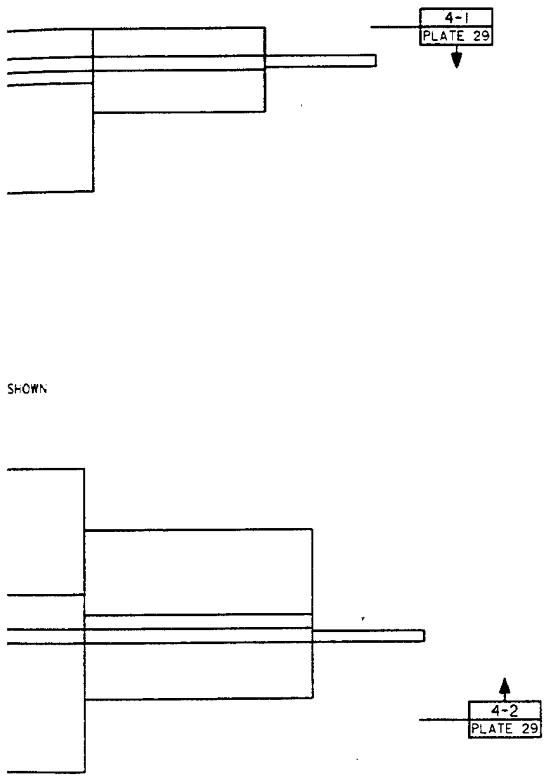
2

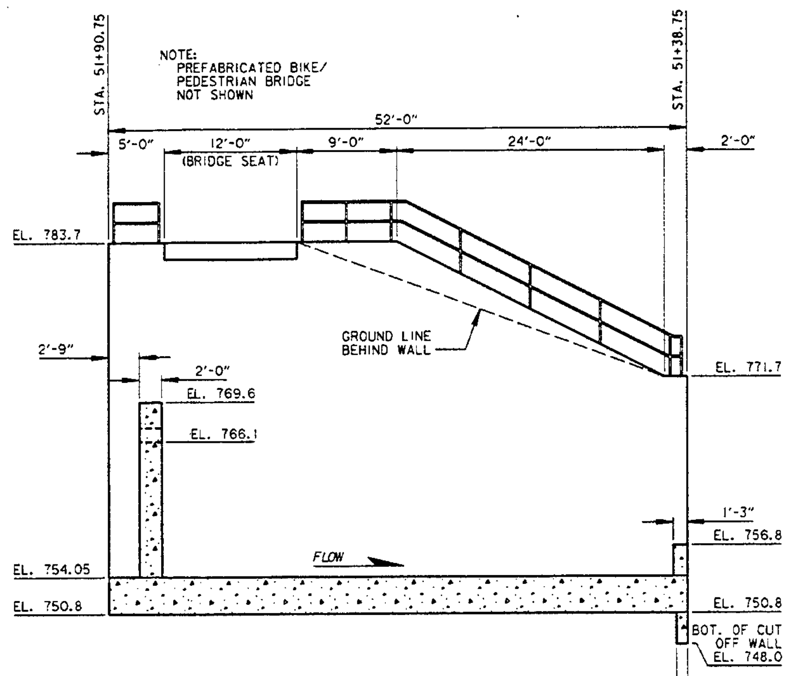


PLAN
DROP STRUCTURE 4
SCALE: ⅛" = 1'-0"

SECTION
DROP STRUCTURE WALL
AT BRIDGE
SCALE: ½"=1'-0"

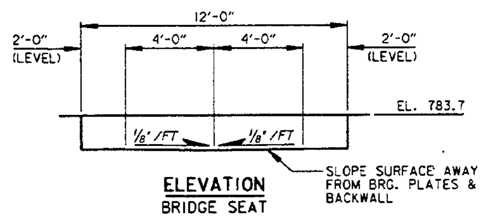
SECTION
DROP STRUCTURE 4
SCALE: ⅛"=1'-0"



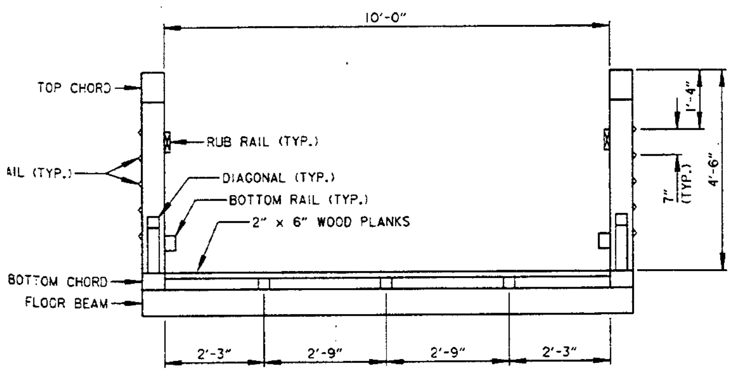


PROFILE
DROP STRUCTURE 4
SCALE: 1/8"=1'-0"

A



ELEVATION
BRIDGE SEAT
SCALE: 1/4" = 1'-0"



SECTION
PREFABRICATED BIKE/
PEDESTRIAN BRIDGE
SCALE: 1/2"=1'-0"

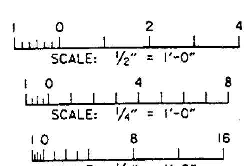
G

NOTES:

1. BRIDGE TO BE FABRICATED TO PRODUCE 0.05' END CAMBER AND 0.3' CENTER CAMBER.
2. NO POINT ON BRIDGE TO BE LOWER THAN EL. 782.2.
3. BRIDGE IS PERPENDICULAR TO DROP STRUCTURE CENTERLINE.
4. ALL BRIDGE DIMENSIONS SUBJECT TO MANUFACTURER'S REQUIREMENTS.

REFERENCES: DWG. NO.

TYPICAL JOINT DETAILS ---------------------------------- PLATE 21

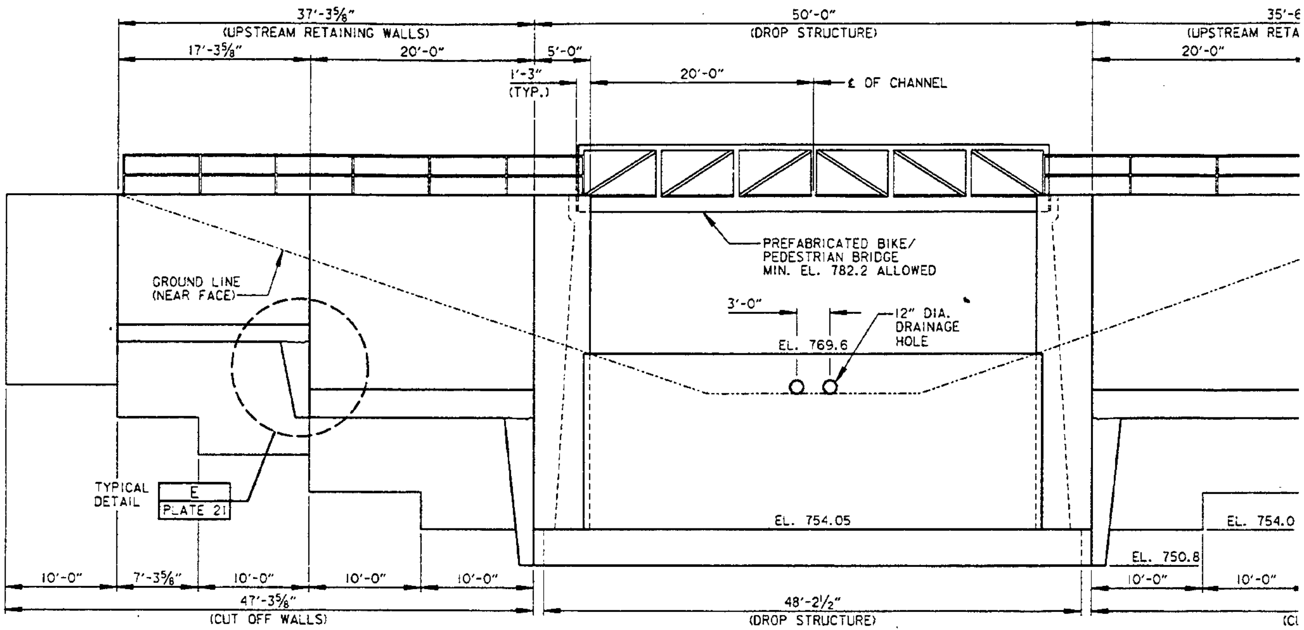


SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:	DESIGN MEMORANDUM CHASKA STAGE 3 FLOOD CONTROL - EAST CREEK CHASKA PROJECT CHASKA, MINNESOTA FLOOD CONTROL DROP STRUCTURE 4 & BRIDGE PLAN, PROFILE, ELEVATION & SECTIONS
ED-D DESIGNED: JHM	
ED-D CHECKED: KDH	
ED-D DRAWN: LKT	
ED-GH DESIGNED: XXX/XXX	
ED-GH CHECKED:	CAD FILE NAME: NCSPRD4A.DGN | DRAWING NUMBER: PLATE 28 | SHT 28
DATE: 09-08-93	SPEC NO: | OF 43

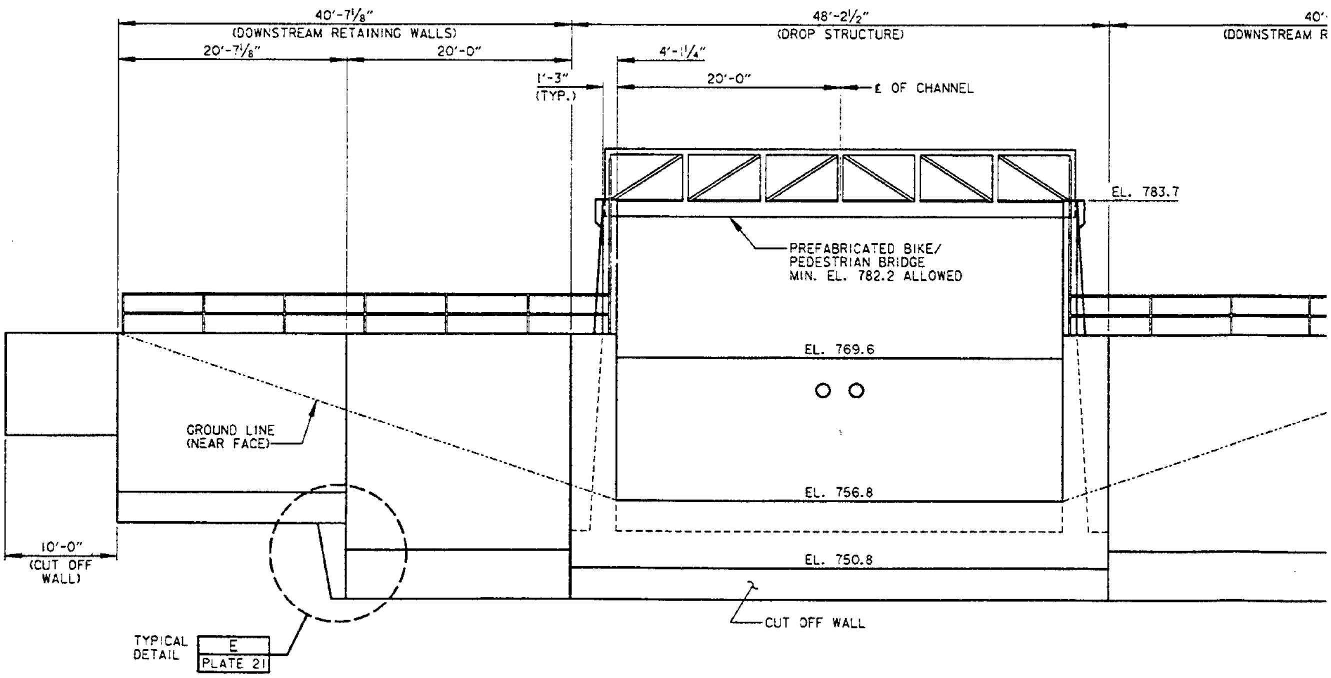
2



ELEVATION 4-1 PLATE 28

DROP STRUCTURE AND UPSTREAM RETAINING WALLS

SCALE: ⅛"=1'-0"

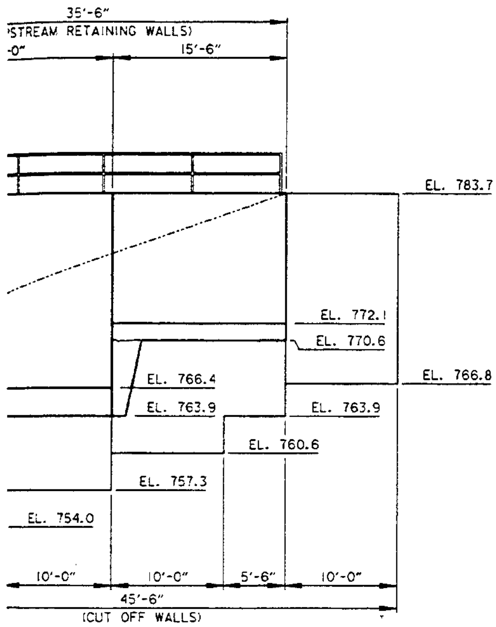


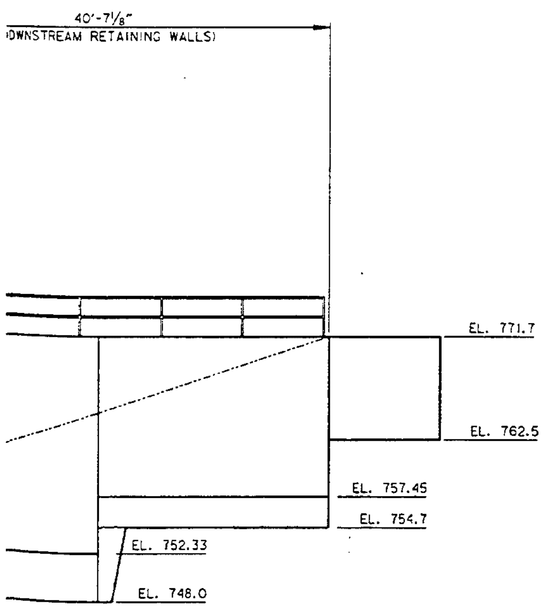
ELEVATION 4-2 PLATE 28

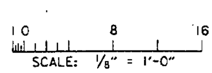
DROP STRUCTURE AND DOWNSTREAM RETAINING WALLS

SCALE: ⅛"=1'-0"

NOTE:
STRUCTURES ARE SYMETRICAL ABOUT THE ℄ OF CHANNEL







SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

DESIGN MEMORANDUM
CHASKA STAGE 3
FLOOD CONTROL - EAST CREEK
CHASKA PROJECT — CHASKA, MINNESOTA

FLOOD CONTROL
DROP STRUCTURE 4 & RETAINING WALLS
ELEVATIONS

ED-D
DESIGNED: JHM
CHECKED: KOH
DRAWN: LKT

ED-GH
DESIGNED: XXX/XXX
CHECKED:

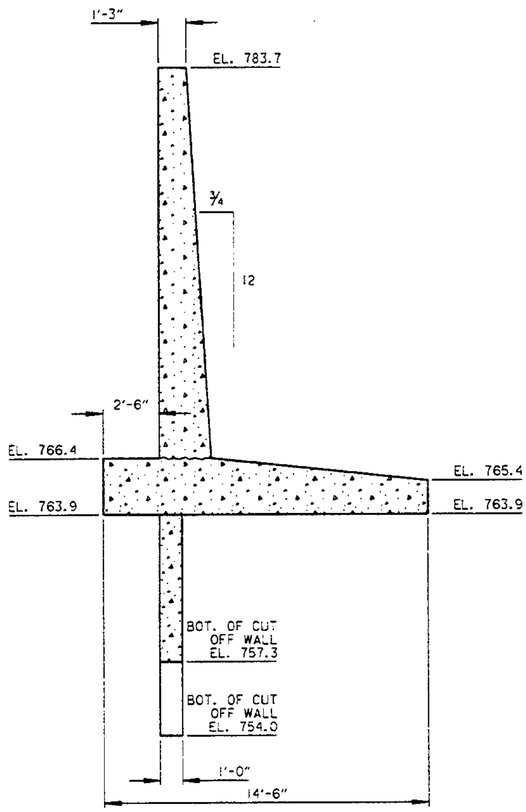
DATE: 12-13-93

CAD FILE NAME: NCSPRD4B.DGN
SPEC NO:

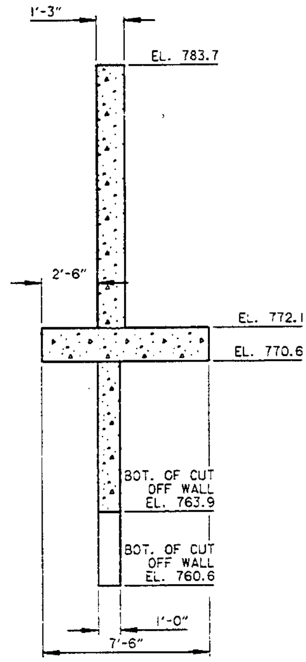
DRAWING NUMBER: PLATE 29

SHT 29 OF 43

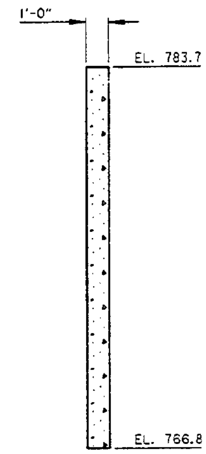
2



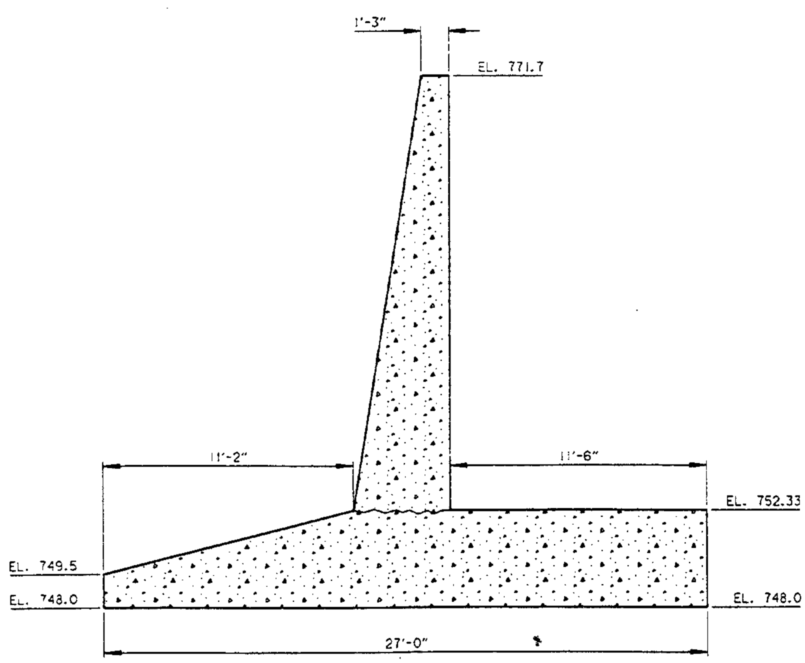
SECTION 4-U1
UPSTREAM RETAINING WALL PLATE 28
SCALE: 1/4"=1'-0"



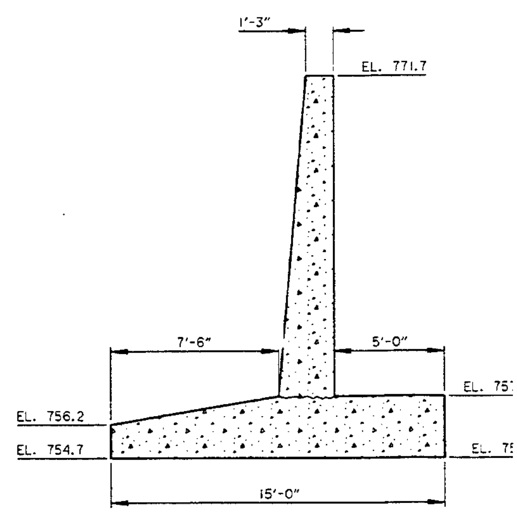
SECTION 4-U2
UPSTREAM RETAINING WALL PLATE 28
SCALE: 1/4"=1'-0"



SECTION
UPSTREAM CUT OFF WALL PL
SCALE: 1/4"=1'-0"



SECTION 4-D1
DOWNSTREAM RETAINING WALL PLATE 28
SCALE: 1/4"=1'-0"

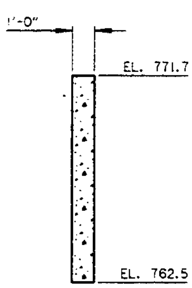


SECTION 4-D2
DOWNSTREAM RETAINING WALL PLATE 28
SCALE: 1/4"=1'-0"

EL. 783.7

EL. 766.8

4-U3
PLATE 28



NOTE:

1. HANDRAIL NOT SHOWN FOR CLARITY.

EL. 757.45

EL. 754.7

SECTION 4-D3 / PLATE 28

DOWNSTREAM CUT OFF WALL

SCALE: 1/4"=1'-0"

SCALE: 1/4" = 1'-0" (0 4 8)

SYMBOL	DESCRIPTION	DATE	APPROVAL

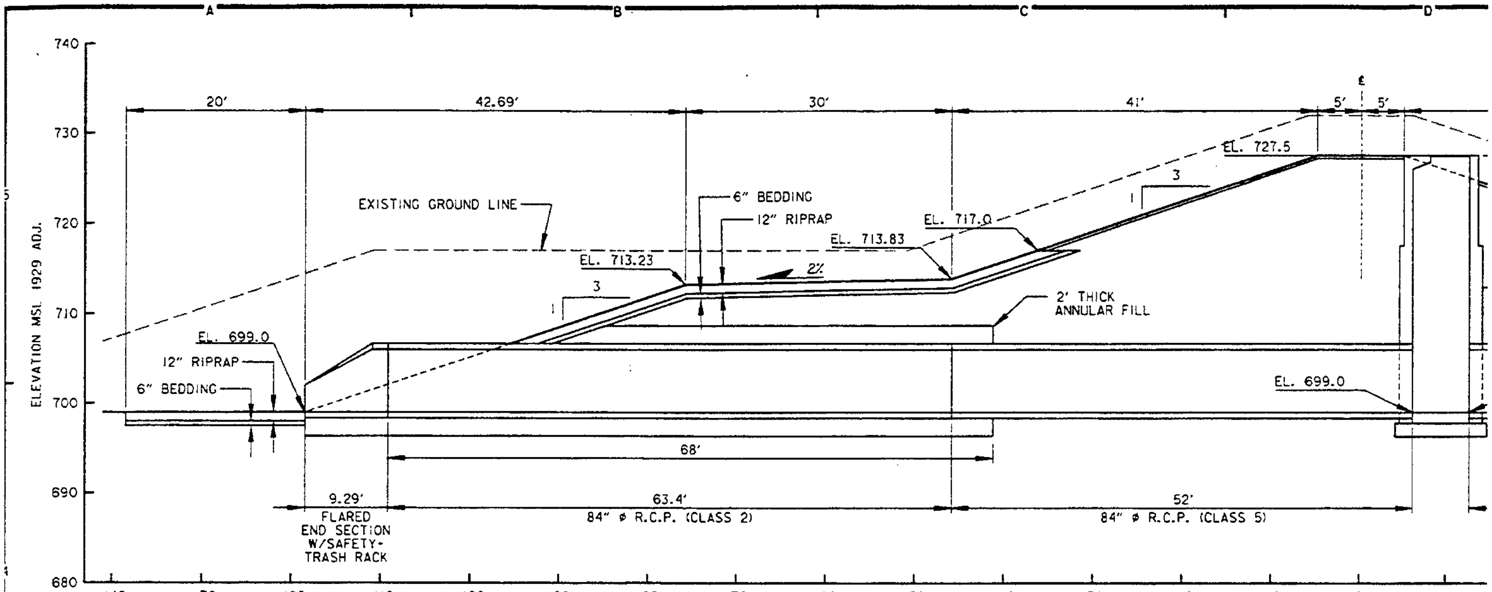
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

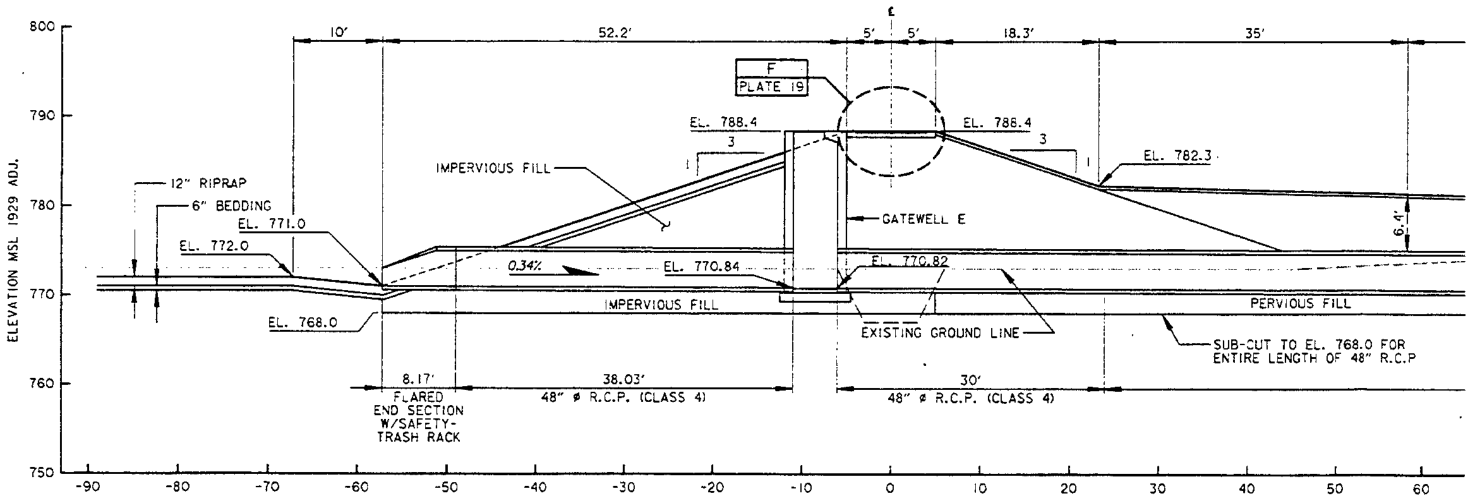
DESIGN MEMORANDUM
CHASKA STAGE 3
FLOOD CONTROL - EAST CREEK
CHASKA PROJECT — CHASKA, MINNESOTA
FLOOD CONTROL
DROP STRUCTURE 4 RETAINING & CUT OFF WALLS
SECTIONS

ED-D	DESIGNED: JHM
	CHECKED: KOH
	DRAWN: LKT
ED-GH	DESIGNED: XXX/XXX
	CHECKED:
DATE: 09-08-93	

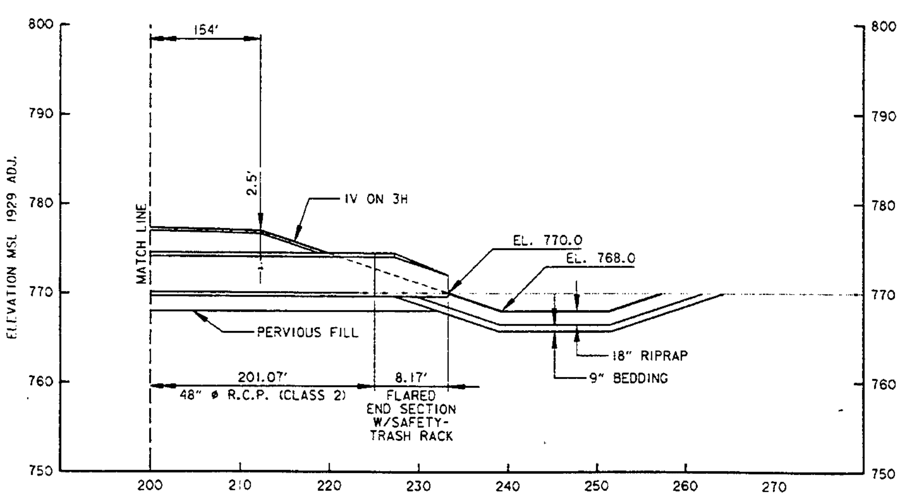
CAD FILE NAME: NCSPRD4C.DGN
SPEC NO:
DRAWING NUMBER: PLATE 30
SHT 30 OF 43



SECTION
OUTLET D
SCALE: 1" = 10'-0"



SECTION
OUTLET E
SCALE: 1" = 10'-0"



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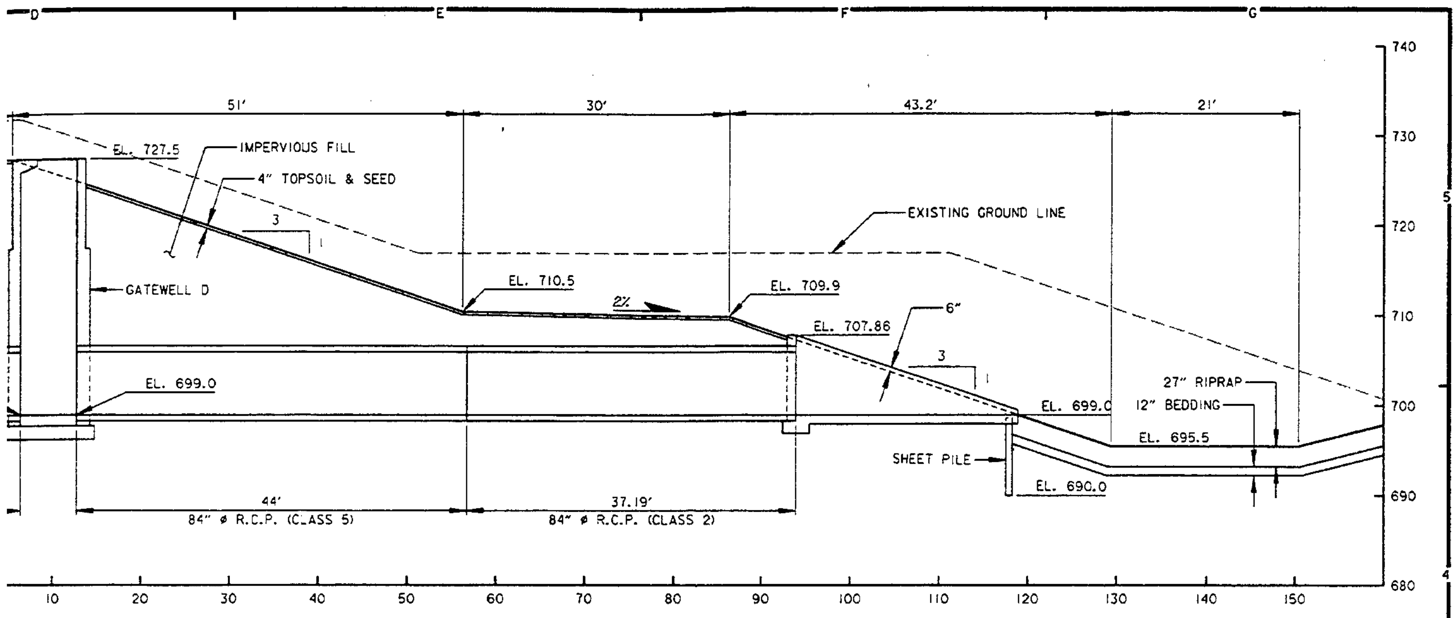
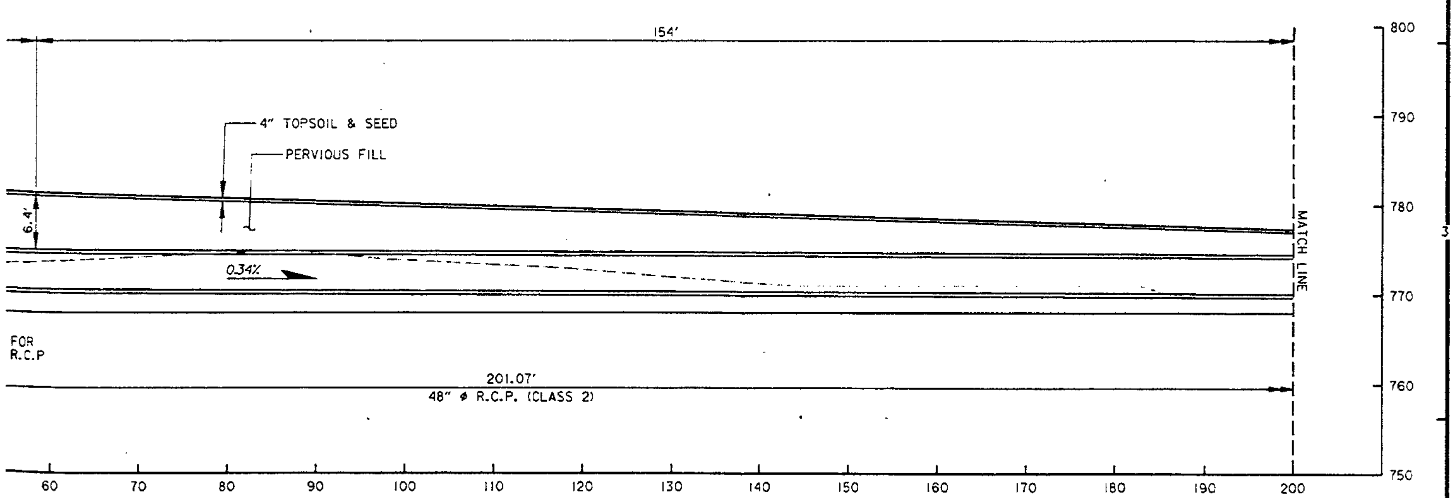


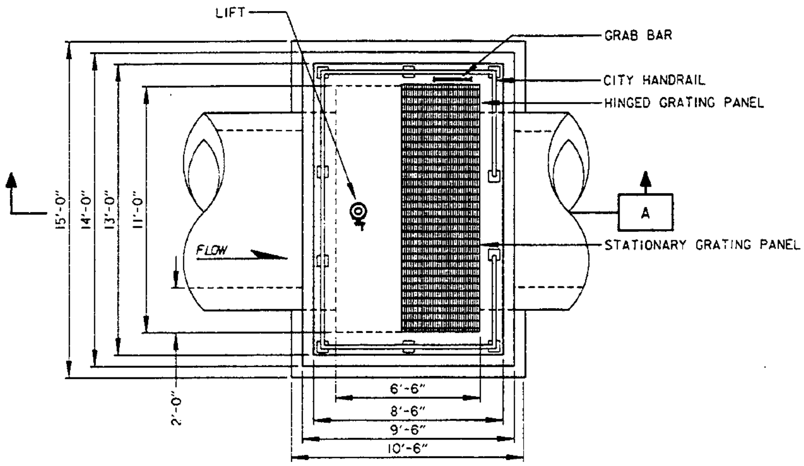


SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

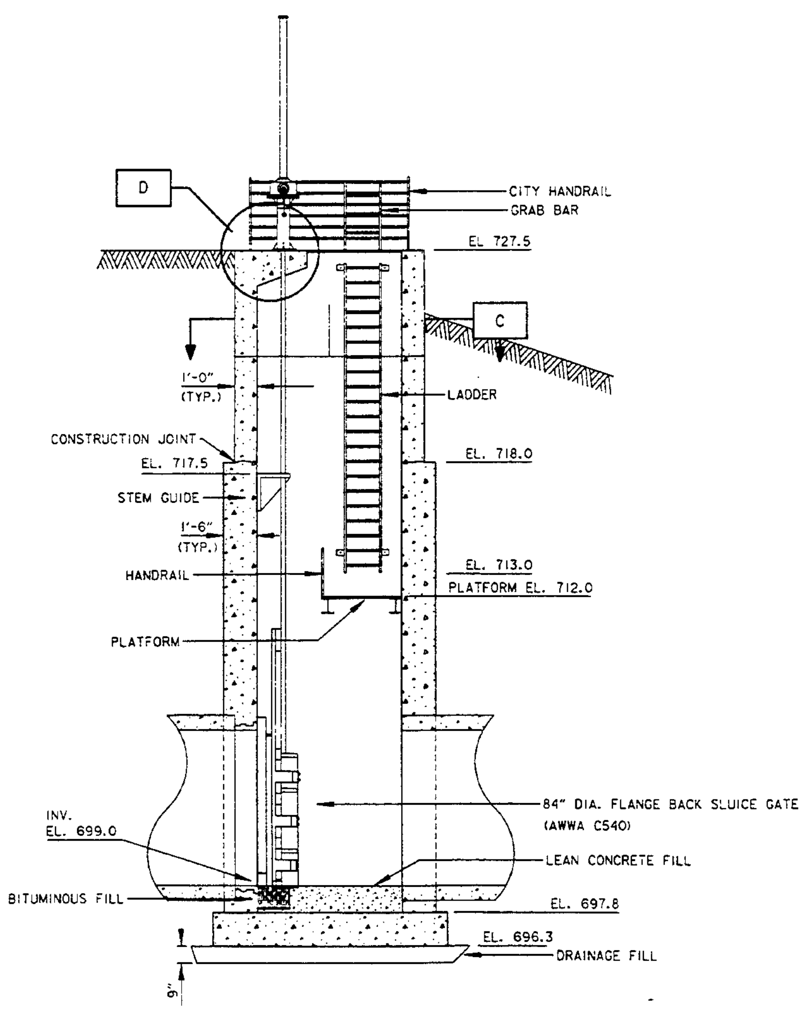
AE APPROVING OFFICIAL:	DESIGN MEMORANDUM CHASKA STAGE 3 FLOOD CONTROL - EAST CREEK CHASKA PROJECT CHASKA, MINNESOTA **FLOOD CONTROL** OUTLETS D AND E SECTIONS
ED-D DESIGNED: MB/JHM	
ED-D CHECKED: KDH	
ED-D DRAWN: LKT	
ED-GH DESIGNED: XXX/XXX	
ED-GH CHECKED:	CAD FILE NAME: NCSPRPP1.DGN — DRAWING NUMBER: — SHT 31
DATE: 12-13-93	SPEC NO: — PLATE 31 — OF 43

2



PLAN
GATEWELL D
SCALE: 1/4"=1'-0"

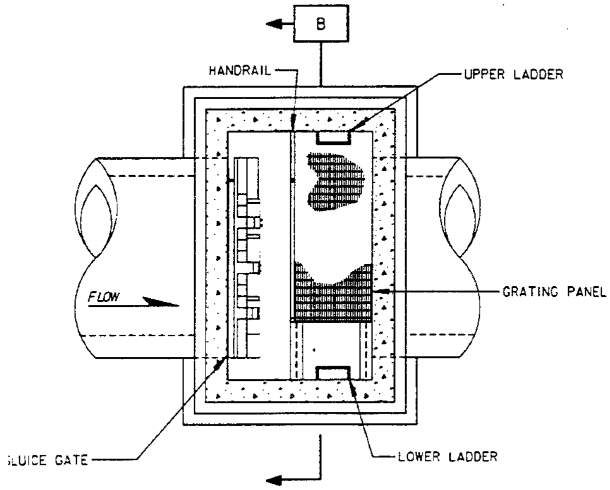
84" DIA. FLANGE BACK SLU.CE G.
(AWWA C540)



STEM

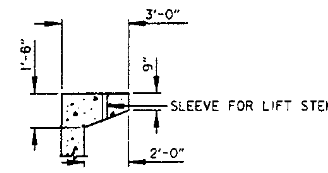
LOWER L

SECTION A
GATEWELL D
SCALE: 1/4"=1'-0"



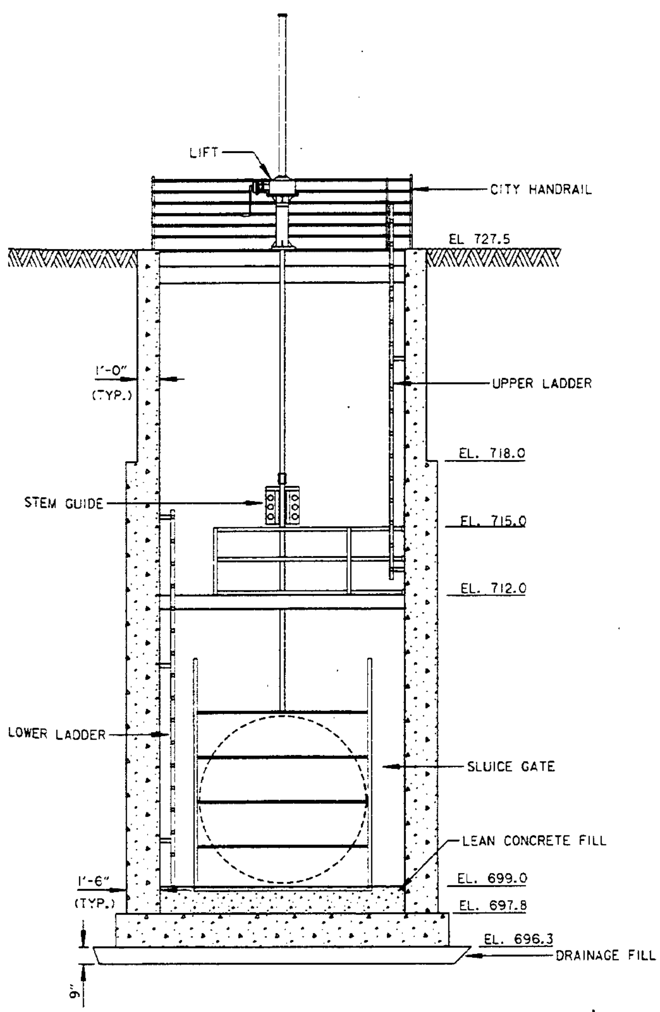
SECTION C

SCALE: 1/4"=1'-0"



DETAIL D

SCALE: 1/4"=1'-0"



SECTION B

GATEWELL D

SCALE: 1/4"=1'-0"

0 4 8

SCALE: 1/4" = 1'-0"

NOTES:

1. FACE BRICK WILL BE ADDED TO EXPOSED CONCRETE WALL. (TO MATCH STAGE 4 BRICKWORK)

2. CITY EMBLEM WILL BE ADDED TO HANDRAIL.

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

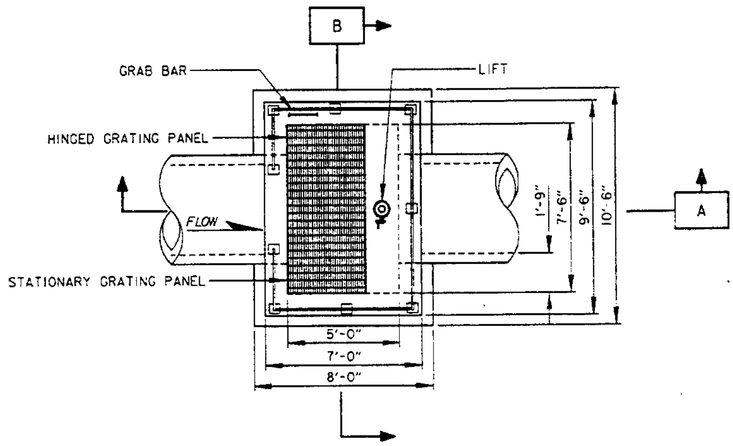
DESIGN MEMORANDUM
CHASKA STAGE 3
FLOOD CONTROL - EAST CREEK
CHASKA PROJECT CHASKA, MINNESOTA
FLOOD CONTROL
GATEWELL D
PLAN, SECTIONS & DETAIL

ED-D	DESIGNED:	TSF
ED-D	CHECKED:	KDH
ED-D	DRAWN:	LAR/LKT
ED-GH	DESIGNED:	XXX/XXX
ED-GH	CHECKED:	
DATE: 11-02-93		

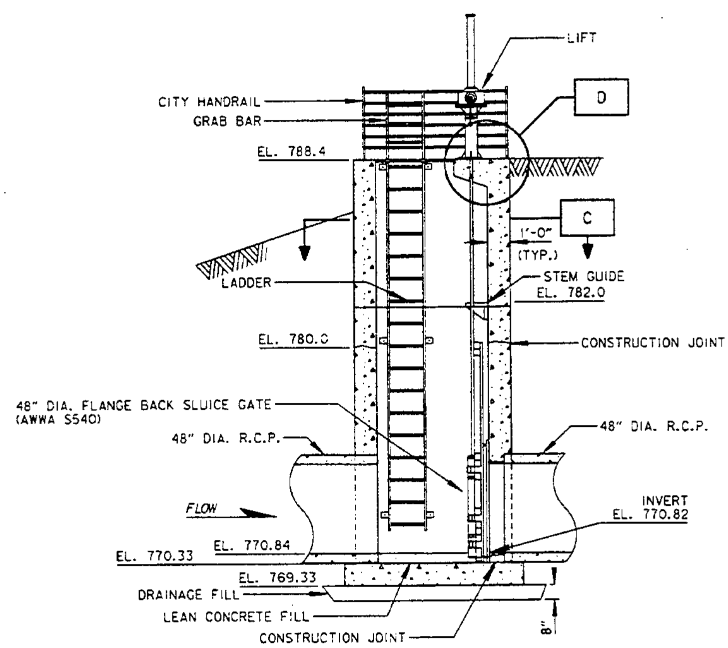
CAD FILE NAME: NCSPR004.DGN | DRAWING NUMBER: PLATE 32 | SHT 32 OF 43

SPEC NO:

(2)



PLAN
GATEWELL E
SCALE: 1/4"=1'-0"

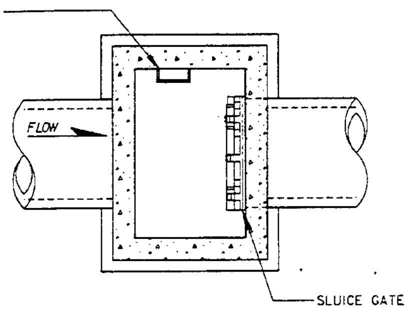


SECTION
GATEWELL E
SCALE: 1/4"=1'-0"

A

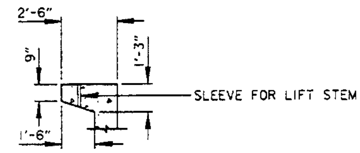
LADDER
FLOW
SECT
SCALE:
1'-0"
(TYP.)
8"
SECTI
GATEW
SCALE:

(1)



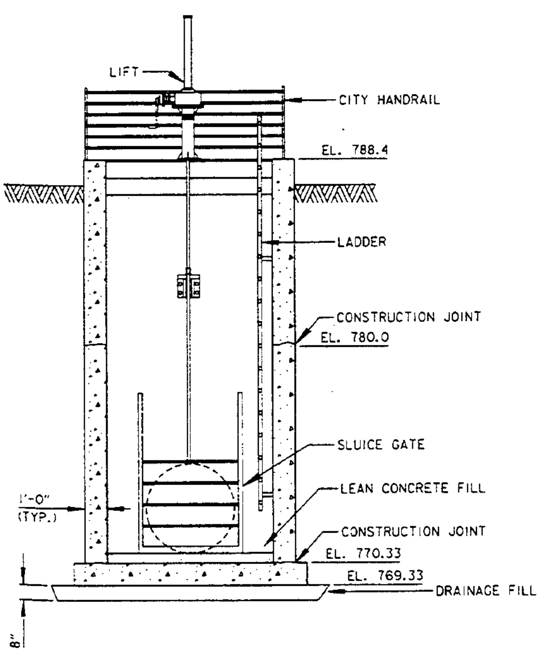
SECTION C

SCALE: 1/4"=1'-0"



DETAIL D

SCALE: 1/4"=1'-0"



SECTION B

GATEWELL E

SCALE: 1/4"=1'-0"

NOTES:

1. FACE BRICK WILL BE ADDED TO EXPOSED CONCRETE WALL. (TO MATCH STAGE 4 BRICKWORK)
2. CITY EMBLEM WILL BE ADDED TO HANDRAIL.

1 0 4 8
SCALE: 1/4" = 1'-0"

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

DESIGN MEMORANDUM
CHASKA STAGE 3
FLOOD CONTROL - EAST CREEK
CHASKA PROJECT CHASKA, MINNESOTA
FLOOD CONTROL
GATEWELL E
PLAN, SECTIONS & DETAIL

ED-D	DESIGNED:	TSF
ED-D	CHECKED:	KDH
ED-D	DRAWN:	LAR/LKT
ED-GH	DESIGNED:	XXX/XXX
ED-GH	CHECKED:	

DATE: 11-02-93

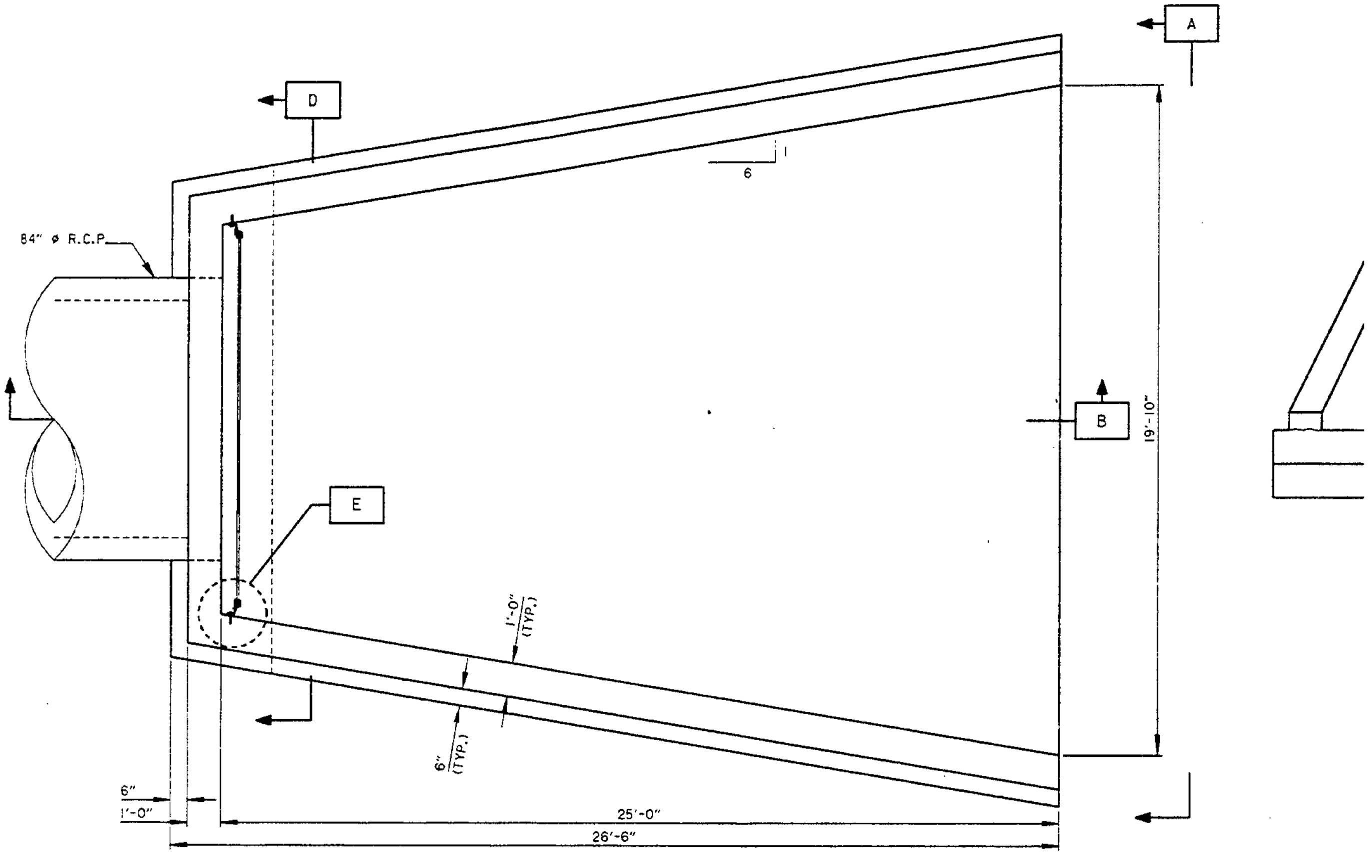
CAD FILE NAME: NCSPR003.DGN

SPEC NO:

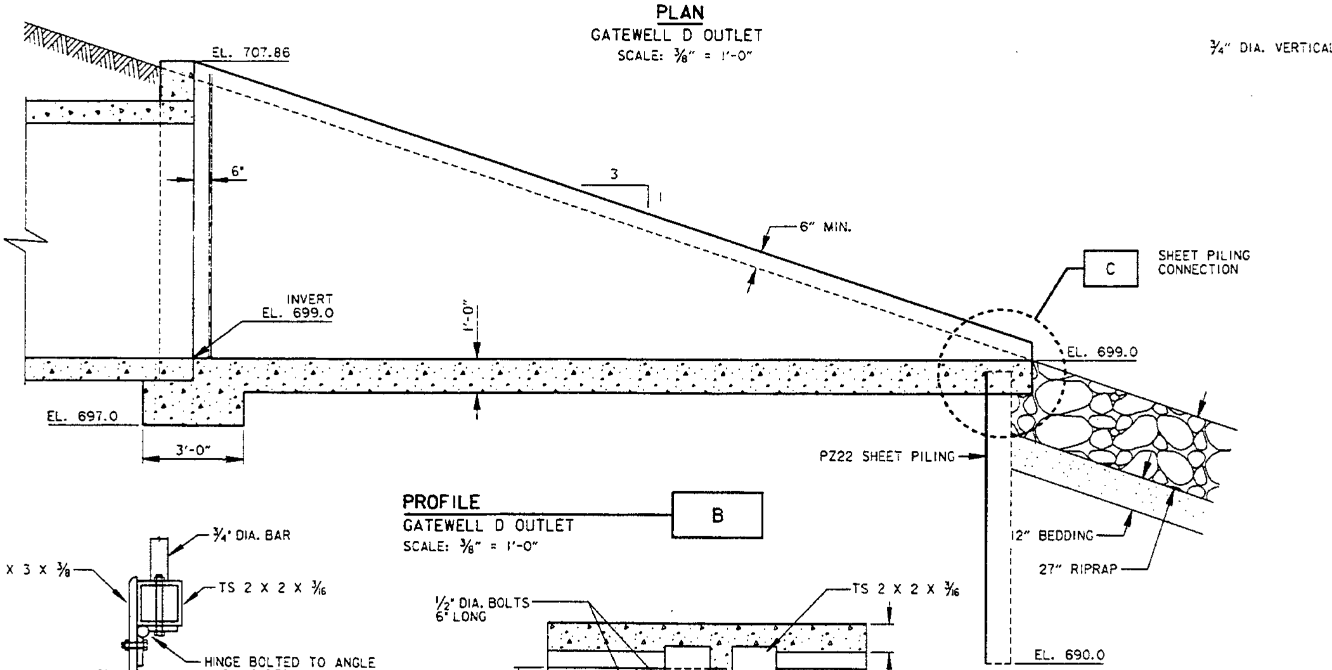
DRAWING NUMBER: PLATE 33

SHT 33 OF 43

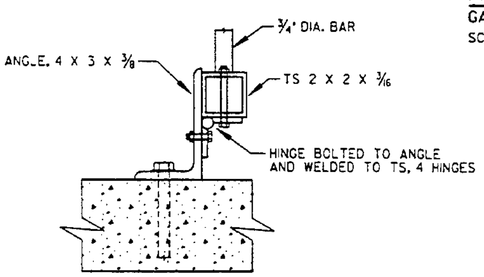
2



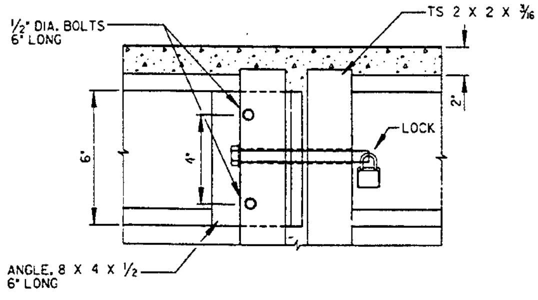
PLAN
GATEWELL D OUTLET
SCALE: 3/8" = 1'-0"



PROFILE
GATEWELL D OUTLET
SCALE: 3/8" = 1'-0"
B

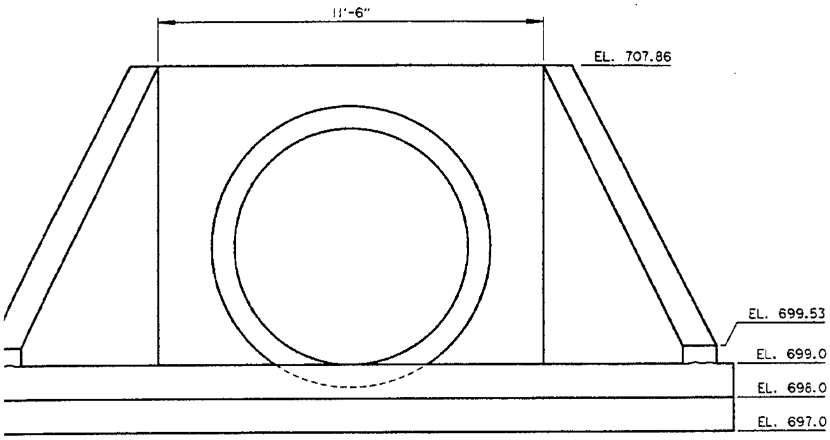


DETAIL
FRAME & HINGE
SCALE: 3" = 1'-0"
E



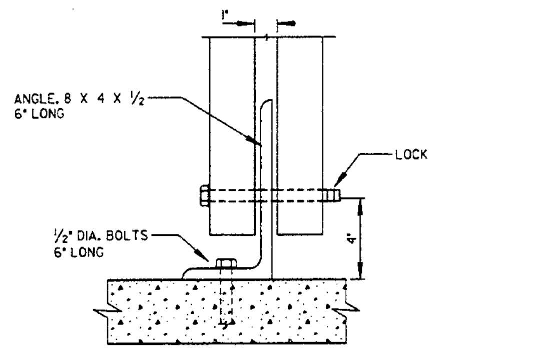
DETAIL
UPPER CONNECTION & LOCK
SCALE: 3" = 1'-0"
F

DETA
SHEET
SCALE:

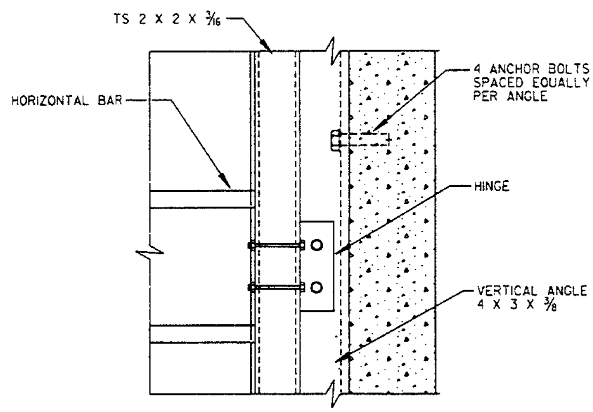


NOTE:
TRASH GATE NOT SHOWN
FOR CLARITY.

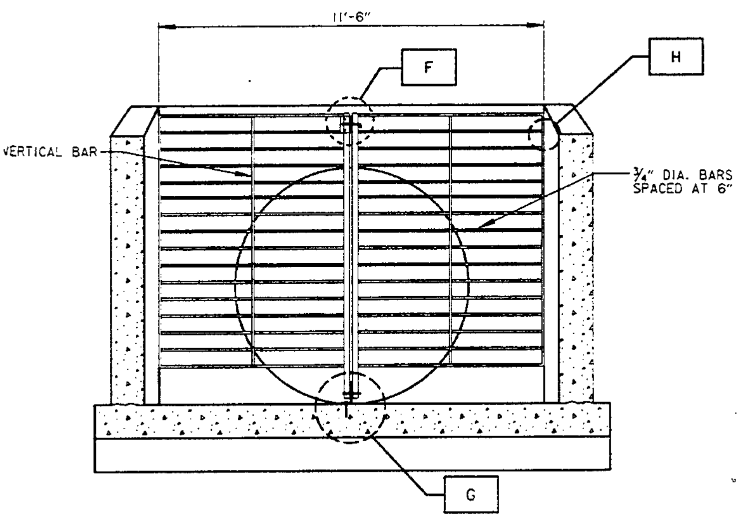
ELEVATION A
GATEWELL D OUTLET
SCALE: 3/8" = 1'-0"



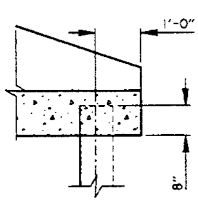
DETAIL G
LOWER CONNECTION
SCALE: 3" = 1'-0"



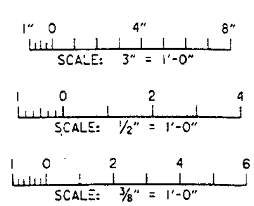
DETAIL H
SCALE: 3" = 1'-0"



SECTION D
TRASH GATE
SCALE: 3/8" = 1'-0"



DETAIL C
SHEET PILING CONNECTION
SCALE: 1/2" = 1'-0"



SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

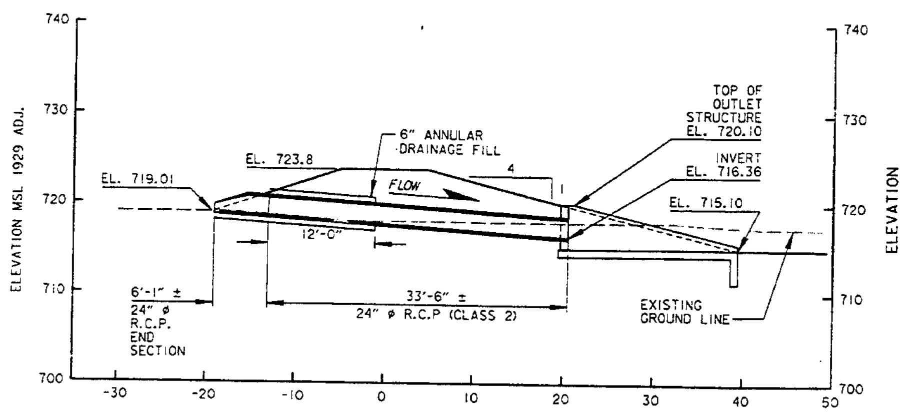
AE APPROVING OFFICIAL:

DESIGN MEMORANDUM
CHASKA STAGE 3
FLOOD CONTROL - EAST CREEK
CHASKA PROJECT — CHASKA, MINNESOTA
FLOOD CONTROL
GATEWELL D OUTLET STRUCTURE
PLAN, PROFILE, ELEVATION & DETAIL

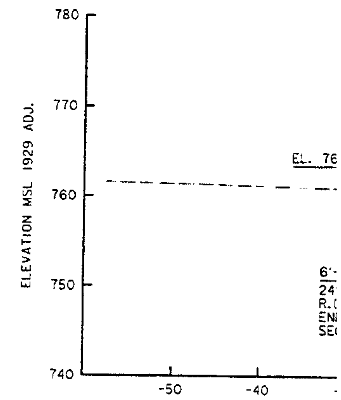
ED-D	DESIGNED:	TSF
ED-D	CHECKED:	KDH
ED-D	DRAWN:	LKT/LAR
ED-GH	DESIGNED:	XXX/XXX
ED-GH	CHECKED:	

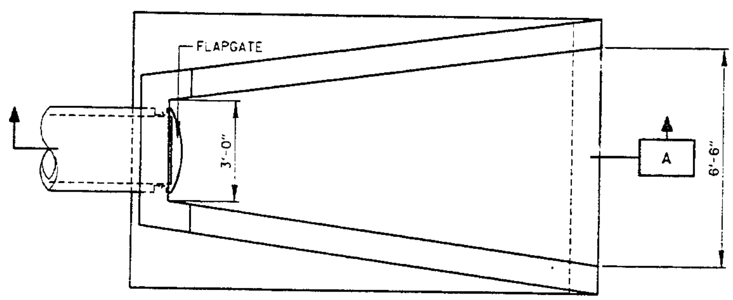
DATE: 09-03-93
CAD FILE NAME: NCSPR311.DGN
SPEC NO:
DRAWING NUMBER: PLATE 34
SHT 34 OF 43

2

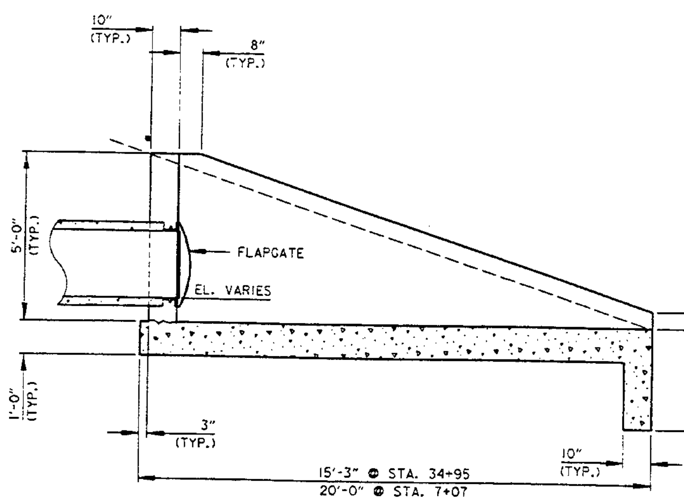


PROFILE
STA. 7+07
SCALE: 1" = 10'-0"



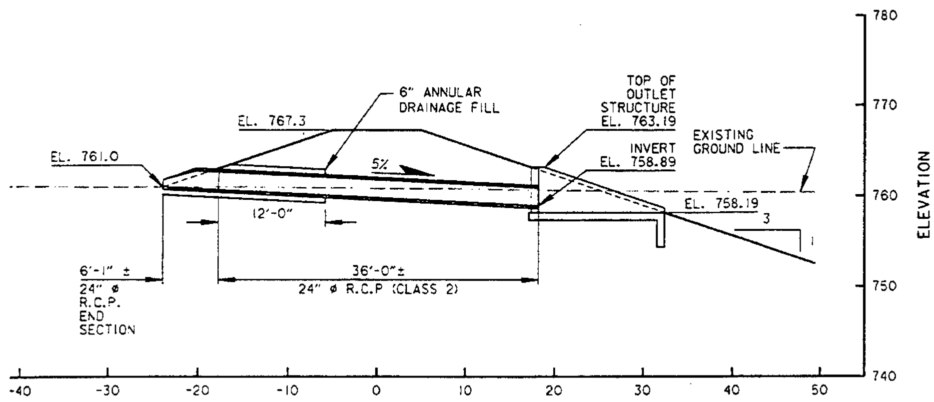


PLAN
TYPICAL OUTLET STA. 7+07 & 34+95
SCALE: 3/8" = 1'-0"



SECTION A
TYPICAL OUTLET
SCALE: 3/8" = 1'-0"

(1)



PROFILE
STA. 34+95
SCALE: 1" = 10'-0"

SCALE: 3/8" = 1'-0"

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

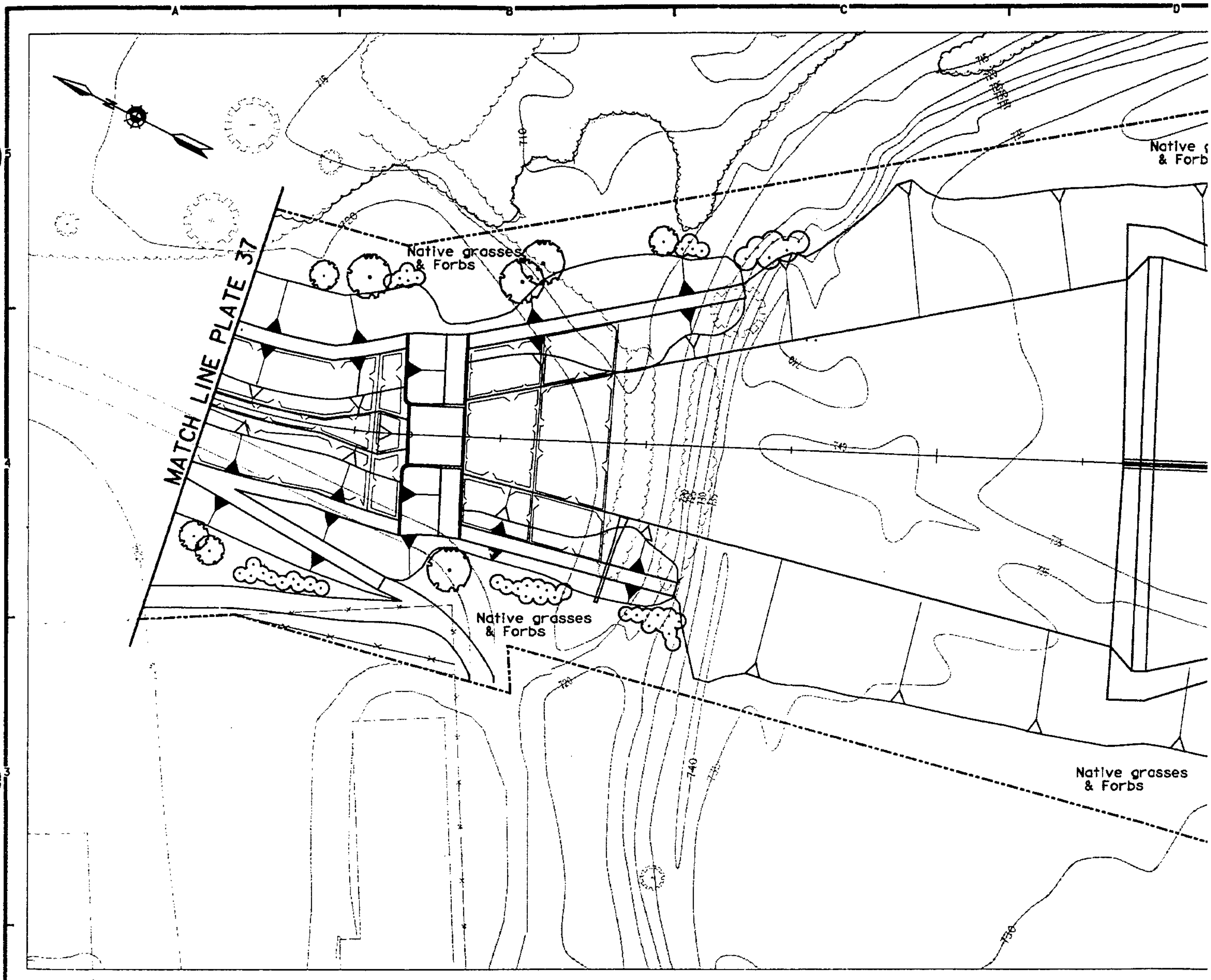
AE APPROVING OFFICIAL:

DESIGN MEMORANDUM
CHASKA STAGE 3
FLOOD CONTROL - EAST CREEK
CHASKA PROJECT CHASKA, MINNESOTA
FLOOD CONTROL
STORM SEWER OUTLETS AT STA. 7+07 AND 34+95
PLAN, PROFILES & SECTION

ED-D	DESIGNED:	BGS/JHM
	CHECKED:	KDH
	DRAWN:	LKT
ED-GH	DESIGNED:	XXX/XXX
	CHECKED:	

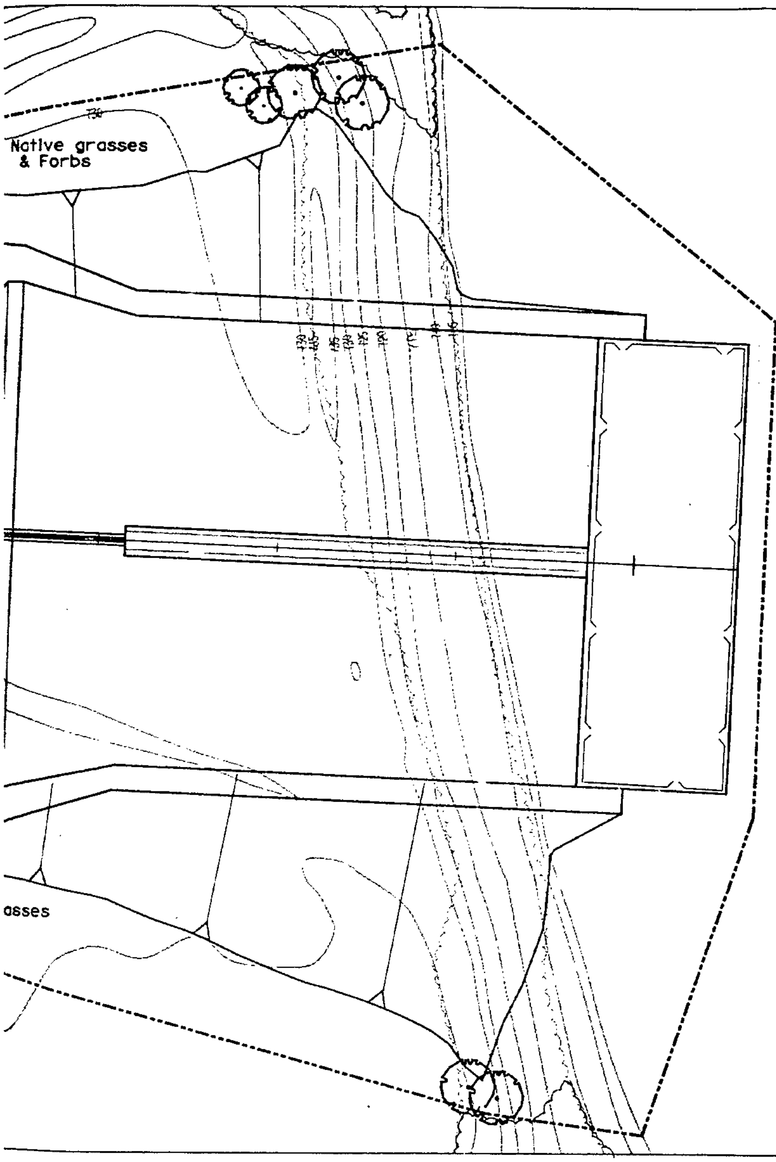
DATE: 09-08-93
CAD FILE NAME: NCSPROLT.DGN
SPEC NO:
DRAWING NUMBER: PLATE 35
SHT 35 OF 43

(2)



PLAN

50 0 50 100
SCALE IN FEET



KEY

- FENCE
- ×××××× RAILING
- EXISITNG VEGETATION
- EXISITNG TREE
- SHADE TREE
- ORNAMENTAL TREE
- CONIFEROUS TREE
- SHRUB MASSING

NOTES:

1. QUANTITY AND PLACEMENT OF OVERBUILD WILL COMPLY WITH CRITERIA SET FORTH IN EM 1110-2-301, 31 MARCH 1993.
2. PLACEMENT OF PLANTINGS AT LEVEES WILL COMPLY WITH CRITERIA SET FORTH IN EM 1110-2-301, 31 MARCH 1993.

REFERENCES:

REFERENCES	PLATE NO.
1. LOCATION, VICINITY MAP, & DRAWING SCHEDULE	1
2. GENERAL PLAN	2
3. PLAN & PROFILE	3
4. LANDSCAPE DETAILS	42,43

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

DESIGN MEMORANDUM
CHASKA - STAGE III
EAST CREEK

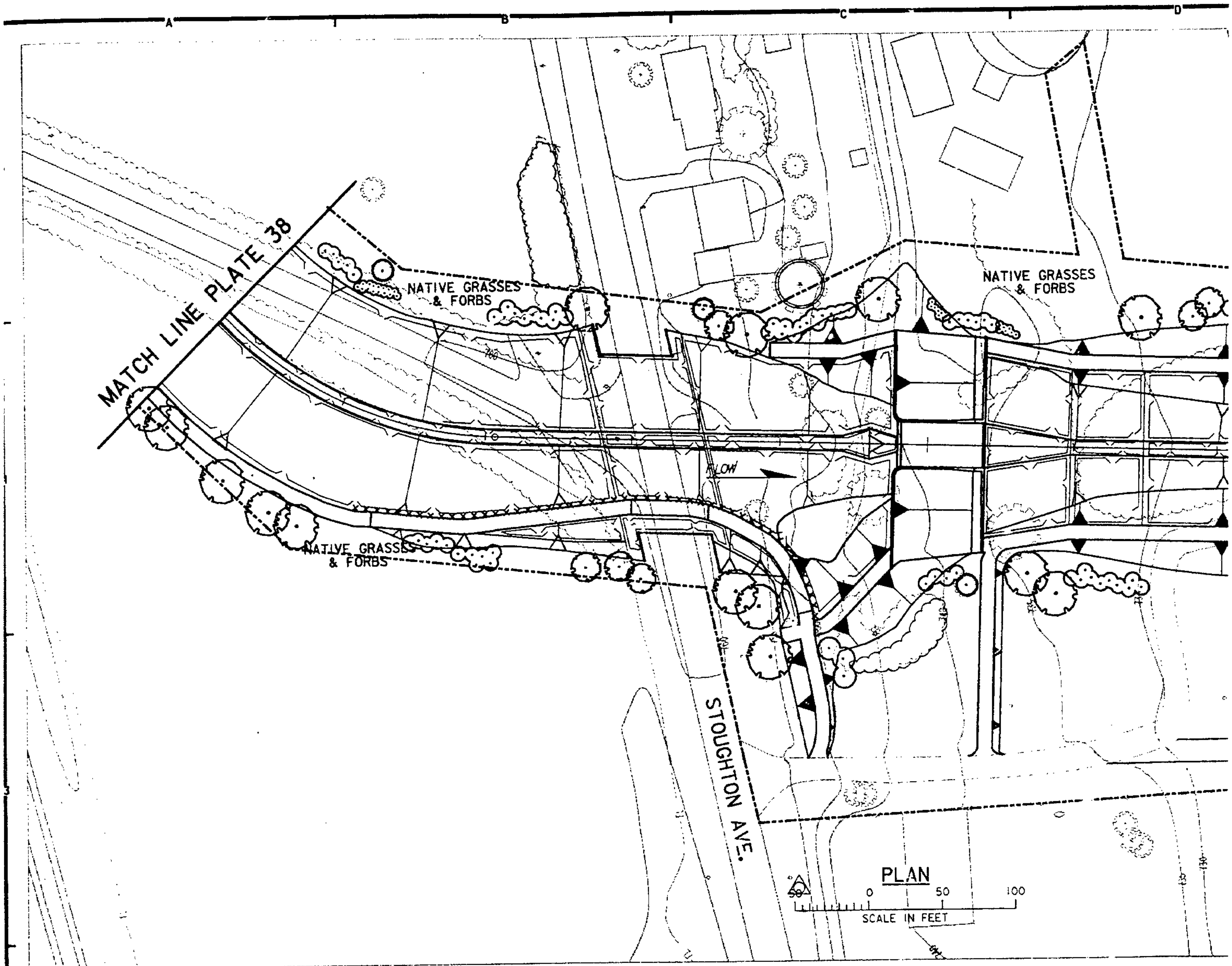
CHASKA PROJECT   CHASKA, MINNESOTA

FLOOD CONTROL

LANDSCAPE DEVELOPMENT
STA. 0+00 TO 10+00

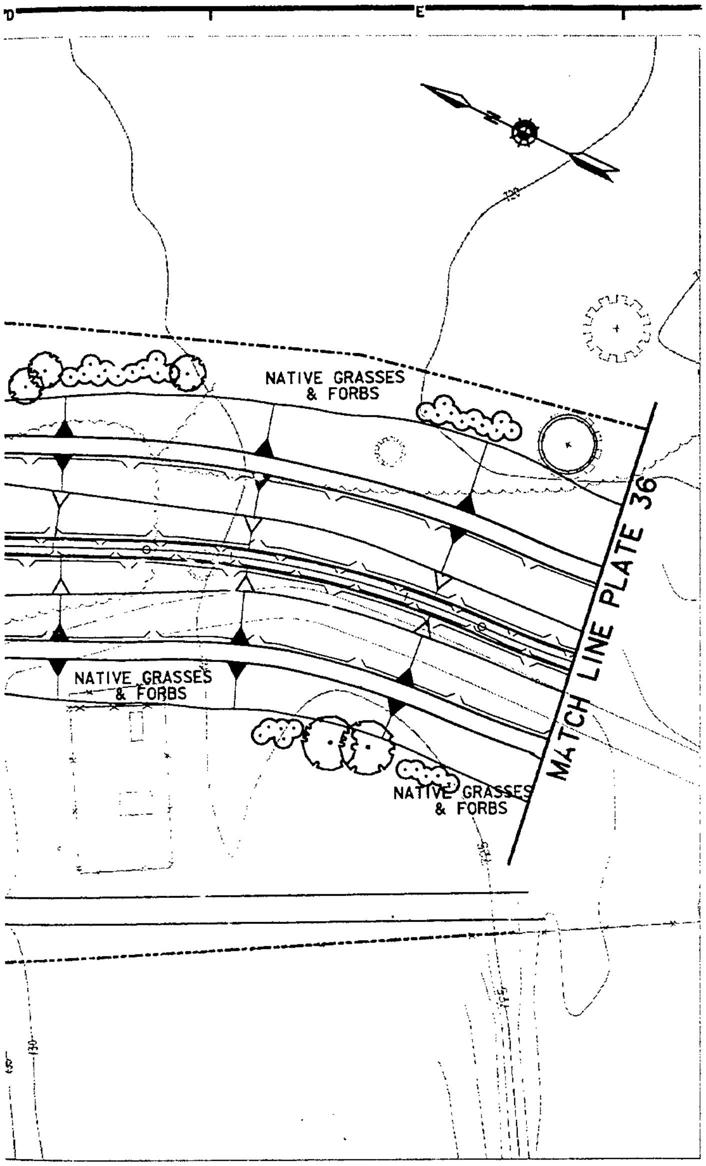
ED-D DESIGNED:	DMS
ED-D CHECKED:	
ED-D DRAWN:	DMS/EMH
ED-GH DESIGNED:	
ED-GH CHECKED:	
DATE:	DECEMBER 1993
CAD FILE NAME:	DPL1.DGN
SPEC NO:	
DRAWING NUMBER:	PLATE 36
SHT	36
OF	43

(2)



MATCH LINE PLATE 38
NATIVE GRASSES & FORBS
NATIVE GRASSES & FORBS
NATIVE GRASSES & FORBS
FLOW
STOUGHTON AVE.
PLAN
0
50
100
SCALE IN FEET

1



KEY

	FENCE
xxxxxx	RAILING
	EXISITNG VEGETATION
	EXISITNG TREE
	SHADE TREE
	ORNAMENTAL TREE
	CONIFEROUS TREE
	SHRUB MASSING

NOTES:

1. QUANTITY AND PLACEMENT OF OVERBUILD WILL COMPLY WITH CRITERIA SET FORTH IN EM 1110-2-301, 31 MARCH 1993.
2. PLACEMENT OF PLANTINGS AT LEVEES WILL COMPLY WITH CRITERIA SET FORTH IN EM 1110-2-301, 31 MARCH 1993.

REFERENCES:

	PLATE NO.
1. LOCATION, VICINITY MAP, & DRAWING SCHEDULE	1
2. GENERAL PLAN	2
3. PLAN & PROFILE	4
4. LANDSCAPE DETAILS	42,43

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

DESIGN MEMORANDUM
CHASKA - STAGE III
EAST CREEK

CHASKA PROJECT — CHASKA, MINNESOTA

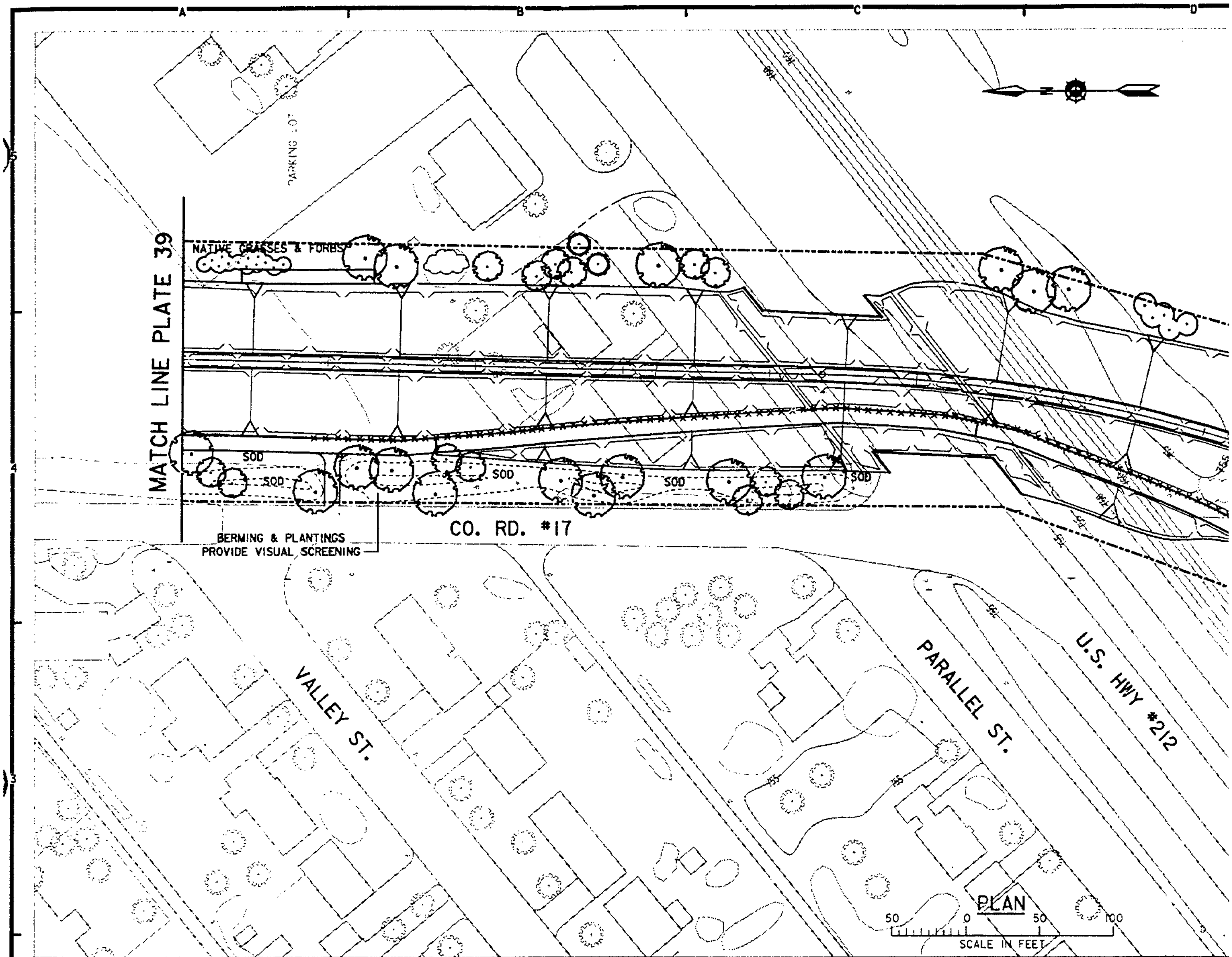
FLOOD CONTROL

LANDSCAPE DEVELOPMENT
STA. 10+00 TO 20+00

ED-D DESIGNED:	DMS
ED-D CHECKED:	
ED-D DRAWN:	DMS/EMH
ED-GH DESIGNED:	
ED-GH CHECKED:	
DATE:	DECEMBER 1993

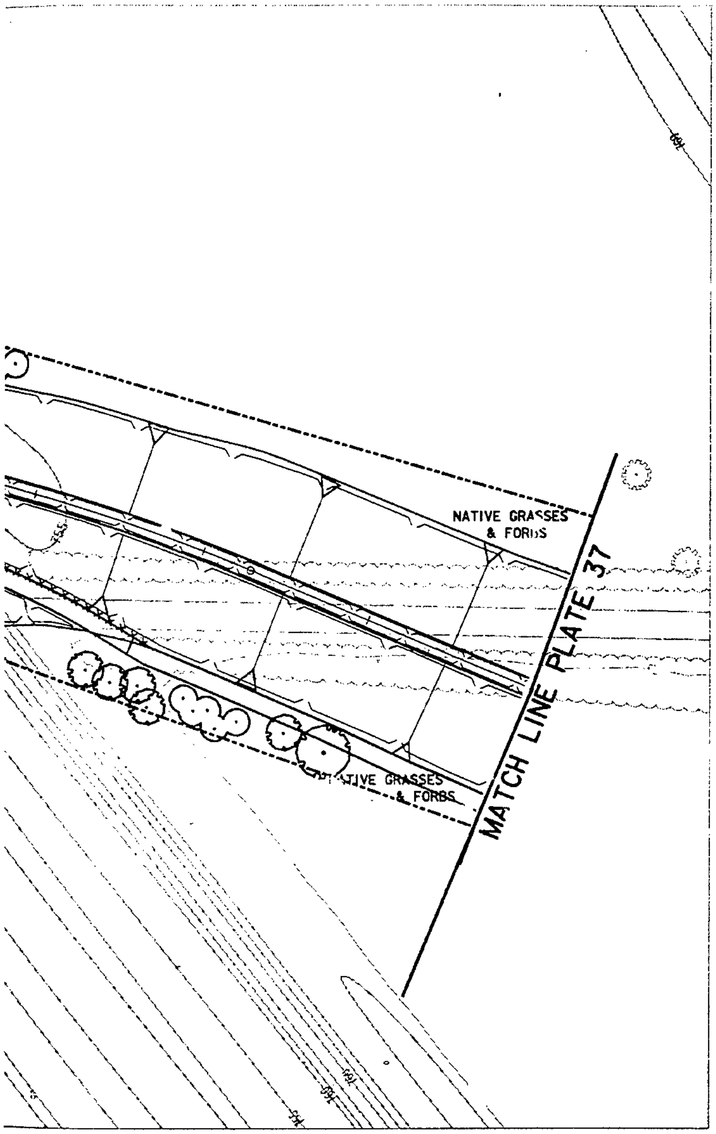
CAD FILE NAME: DPL2.DGN
SPEC NO:
DRAWING NUMBER: PLATE 37
SHT 37 OF 43

9



MATCH LINE PLATE 39
NATIVE GRASSES & FORBS
SOD
BERMING & PLANTINGS
PROVIDE VISUAL SCREENING
CO. RD. #17
VALLEY ST.
PARALLEL ST.
U.S. HWY #212
PARKING LOT
PLAN
50 0 50 100
SCALE IN FEET

(1)



KEY

- FENCE
- RAILING
- EXISITNG VEGETATION
- EXISITNG TREE
- SHADE TREE
- ORNAMENTAL TREE
- CONIFEROUS TREE
- SHRUB MASSING

NOTES:

1. QUANTITY AND PLACEMENT OF OVERBUILD WILL COMPLY WITH CRITERIA SET FORTH IN EM 1110-2-301, 31 MARCH 1993.
2. PLACEMENT OF PLANTINGS AT LEVEES WILL COMPLY WITH CRITERIA SET FORTH IN EM 1110-2-301, 3 MARCH 1993.

REFERENCES:

REFERENCES	PLATE NO.
1. LOCATION, VICINITY MAP, & DRAWING SCHEDULE	1
2. GENERAL PLAN	2
3. PLAN & PROFILE	5
4. LANDSCAPE DETAILS	42, 43

SYMBOL	DESCRIPTION	DATE	APPROVAL

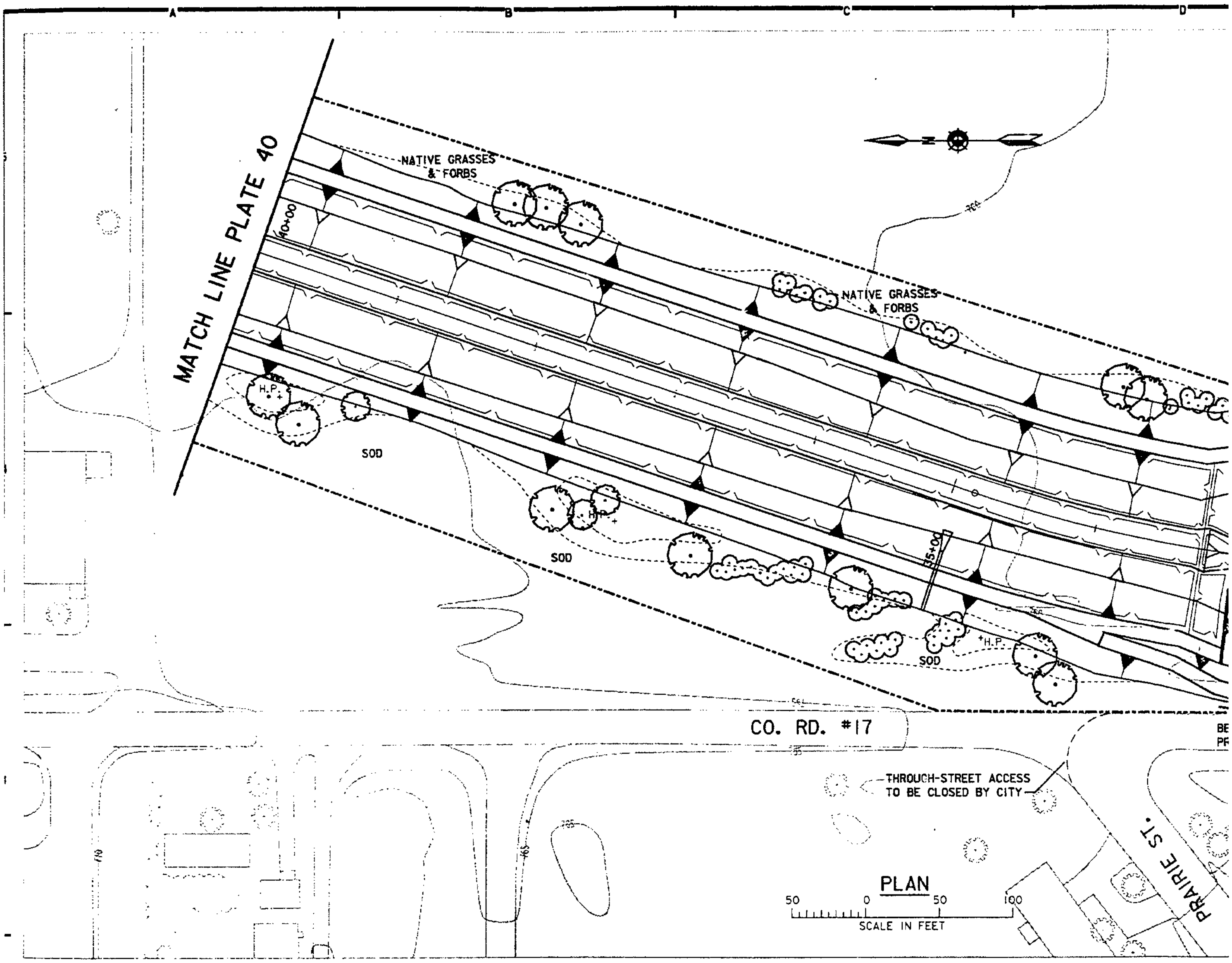
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

DESIGN MEMORANDUM
CHASKA - STAGE III
EAST CREEK
CHASKA PROJECT — CHASKA, MINNESOTA
FLOOD CONTROL
LANDSCAPE PLAN
STA. 20+00 TO 30+00

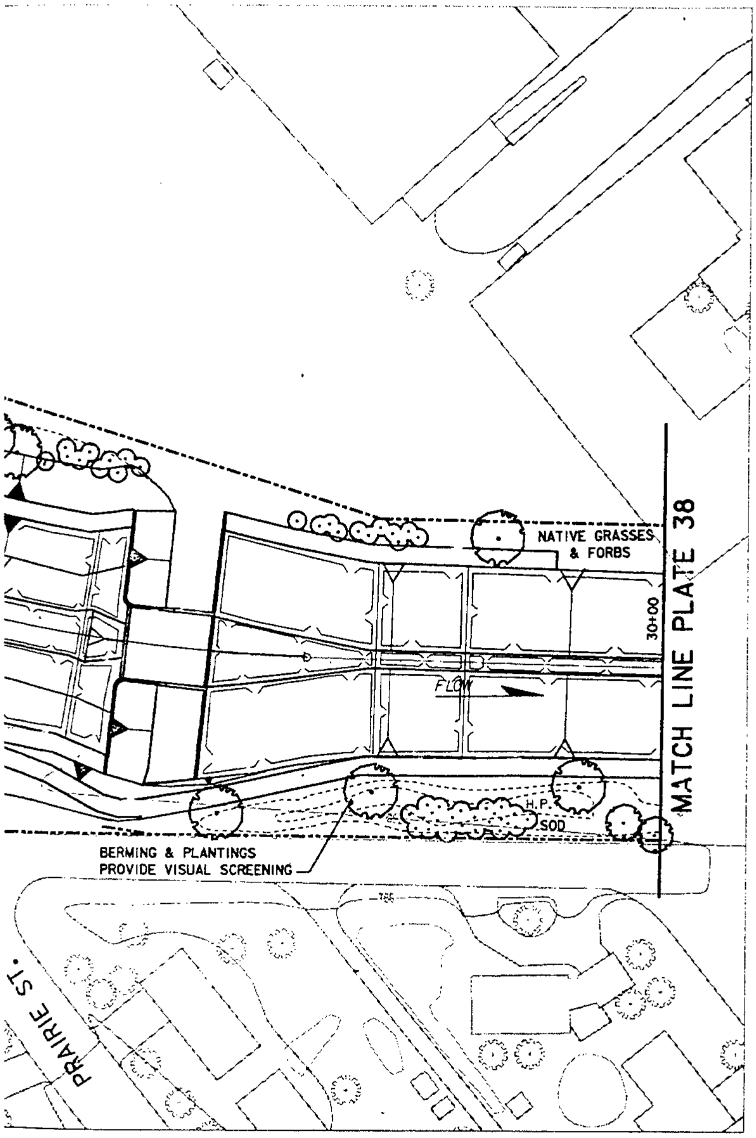
ED-D: DESIGNED: DMS; CHECKED:; DRAWN: DMS/EMH
ED-CH: DESIGNED:; CHECKED:
DATE: DECEMBER 1993
CAD FILE NAME: DPL3.DGN
SPEC NO:
DRAWING NUMBER: PLATE 38
SHT 38 OF 43

(2)



MATCH LINE PLATE 40
40+00
NATIVE GRASSES & FORBS
NATIVE GRASSES & FORBS
H.P.
SOD
H.P.
SOD
35+00
H.P.
SOD
CO. RD. #17
THROUGH-STREET ACCESS TO BE CLOSED BY CITY
PRAIRIE ST.
PLAN
50 0 50 100
SCALE IN FEET

(1)



KEY

- FENCE
- RAILING
- EXISITNG VEGETATION
- EXISITNG TREE
- SHADE TREE
- ORNAMENTAL TREE
- CONIFEROUS TREE
- SHRUB MASSING

NOTES:

1. QUANTITY AND PLACEMENT OF OVERBUILD WILL COMPLY WITH CRITERIA SET FORTH IN EM 1110-2-301, 31 MARCH 1993.
2. PLACEMENT OF PLANTINGS AT LEVEES WILL COMPLY WITH CRITERIA SET FORTH IN EM 1110-2-301, 31 MARCH 1993.

REFERENCES:

	REFERENCES	PLATE NO.
1.	LOCATION, VICINITY MAP, & DRAWING SCHEDULE	1
2.	GENERAL PLAN	2
3.	PLAN & PROFILE	6
4.	LANDSCAPE DETAILS	42, 43

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

DESIGN MEMORANDUM
CHASKA - STAGE III
EAST CREEK

CHASKA PROJECT — CHASKA, MINNESOTA

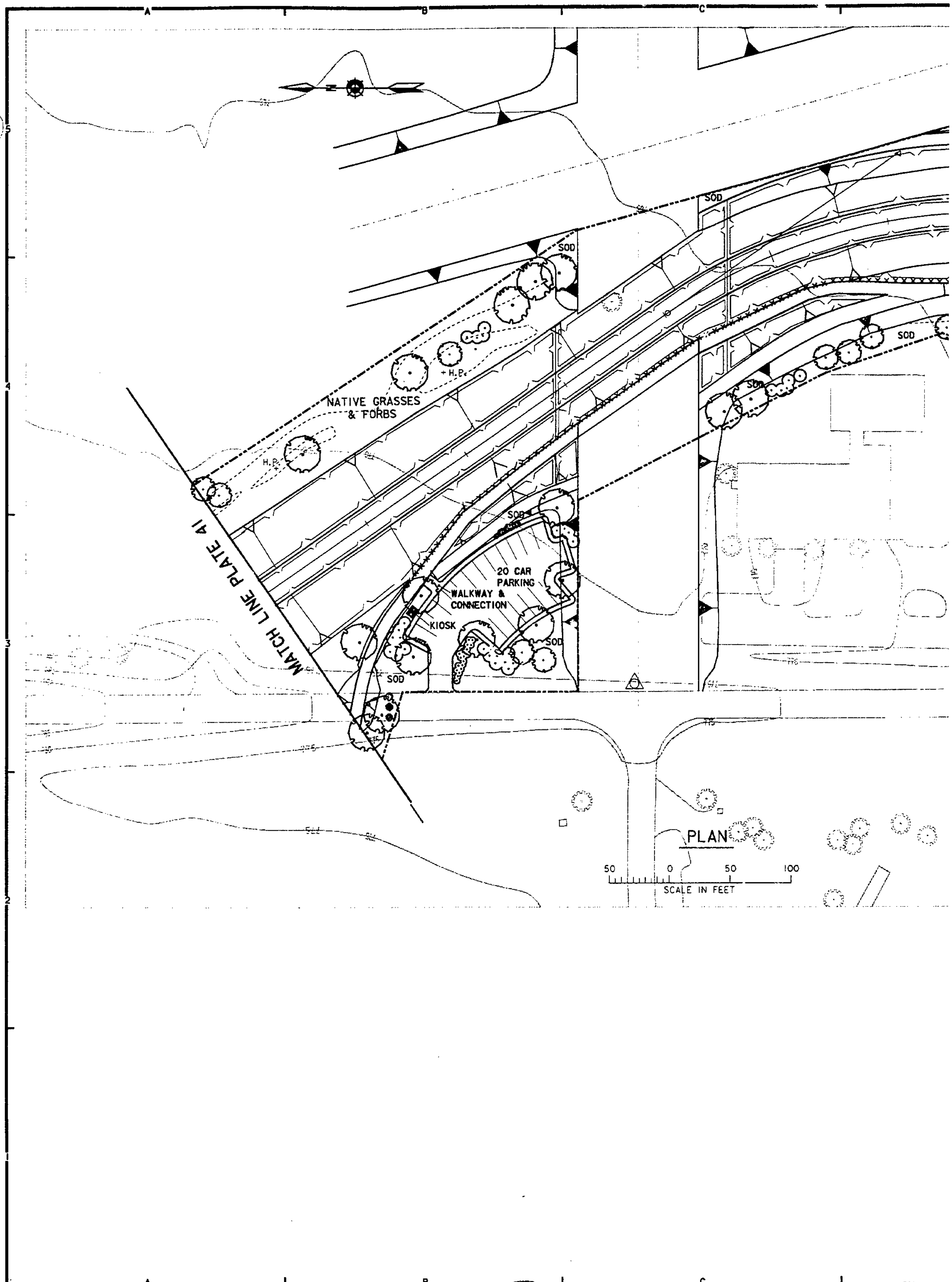
FLOOD CONTROL

LANDSCAPE PLAN
STA. 30+00 TO 40+00

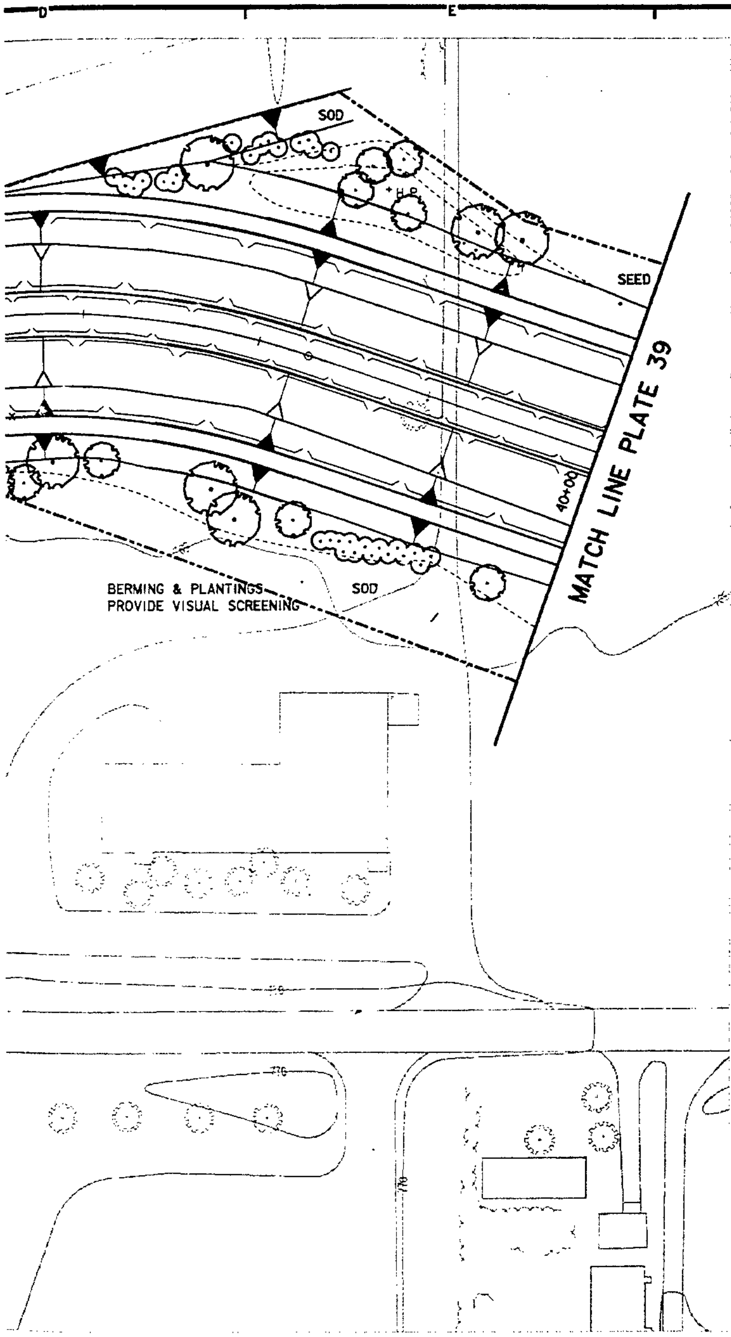
ED-D	DESIGNED:	DMS
ED-D	CHECKED:	
ED-D	DRAWN:	DMS/EMH
ED-GH	DESIGNED:	
ED-GH	CHECKED:	

DATE: DECEMBER 1993 | CAD FILE NAME: DPL4.DGN | SPEC NO: | DRAWING NUMBER: PLATE 39 | SHT 39 OF 43

(9)



NATIVE GRASSES & FORBS
SOD
H.P.
20 CAR PARKING
WALKWAY & CONNECTION
KIOSK
MATCH LINE PLATE 41
PLAN
50 0 50 100
SCALE IN FEET
A
B
C



KEY

FENCE

×××××× RAILING

EXISITNG VEGETATION

EXISITNG TREE

SHADE TREE

ORNAMENTAL TREE

CONIFEROUS TREE

SHRUB MASSING

NOTES:

1. QUANTITY AND PLACEMENT OF OVERBUILD WILL COMPLY WITH CRITERIA SET FORTH IN EM 1110-2-301, 31 MARCH 1993.
2. PLACEMENT OF PLANTINGS AT LEVEES WILL COMPLY WITH CRITERIA SET FORTH IN EM 1110-2-301, 31 MARCH 1993.

REFERENCES:	PLATE NO.
1. LOCATION, VICINITY MAP, & DRAWING SCHEDULE	1
2. GENERAL PLAN	2
3. PLAN & PROFILE	7
4. LANDSCAPE DETAILS	42, 43

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

DESIGN MEMORANDUM
CHASKA - STAGE III
EAST CREEK

CHASKA PROJECT CHASKA, MINNESOTA

FLOOD CONTROL

LANDSCAPE PLAN
STA. 40+00 TO 50+00

ED-D	DESIGNED:	DMS
	CHECKED:	
	DRAWN:	DMS/EMH
ED-GH	DESIGNED:	
	CHECKED:	

DATE: DECEMBER 1993

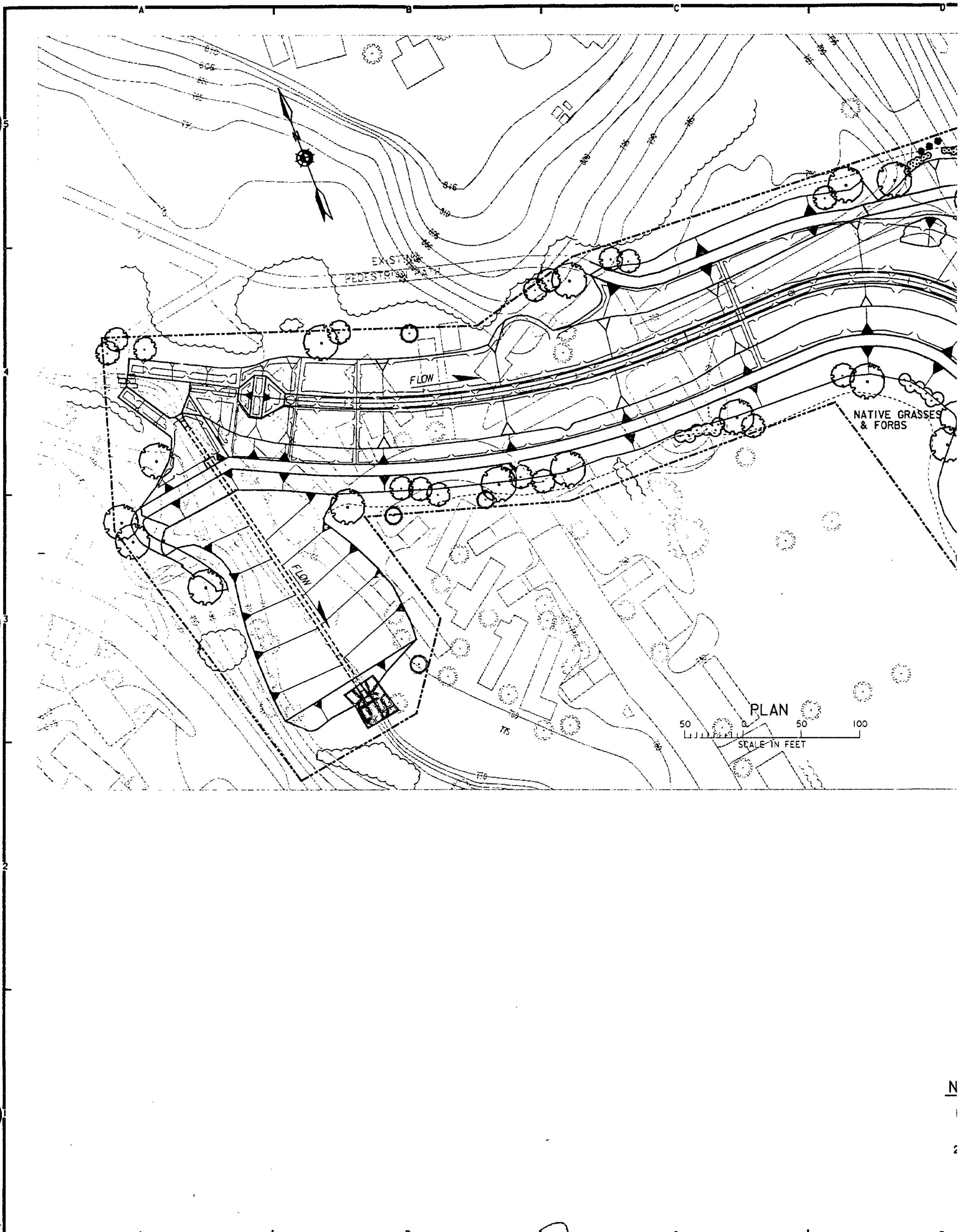
CAD FILE NAME: DPL5.DGN

SPEC NO:

DRAWING NUMBER: PLATE 40

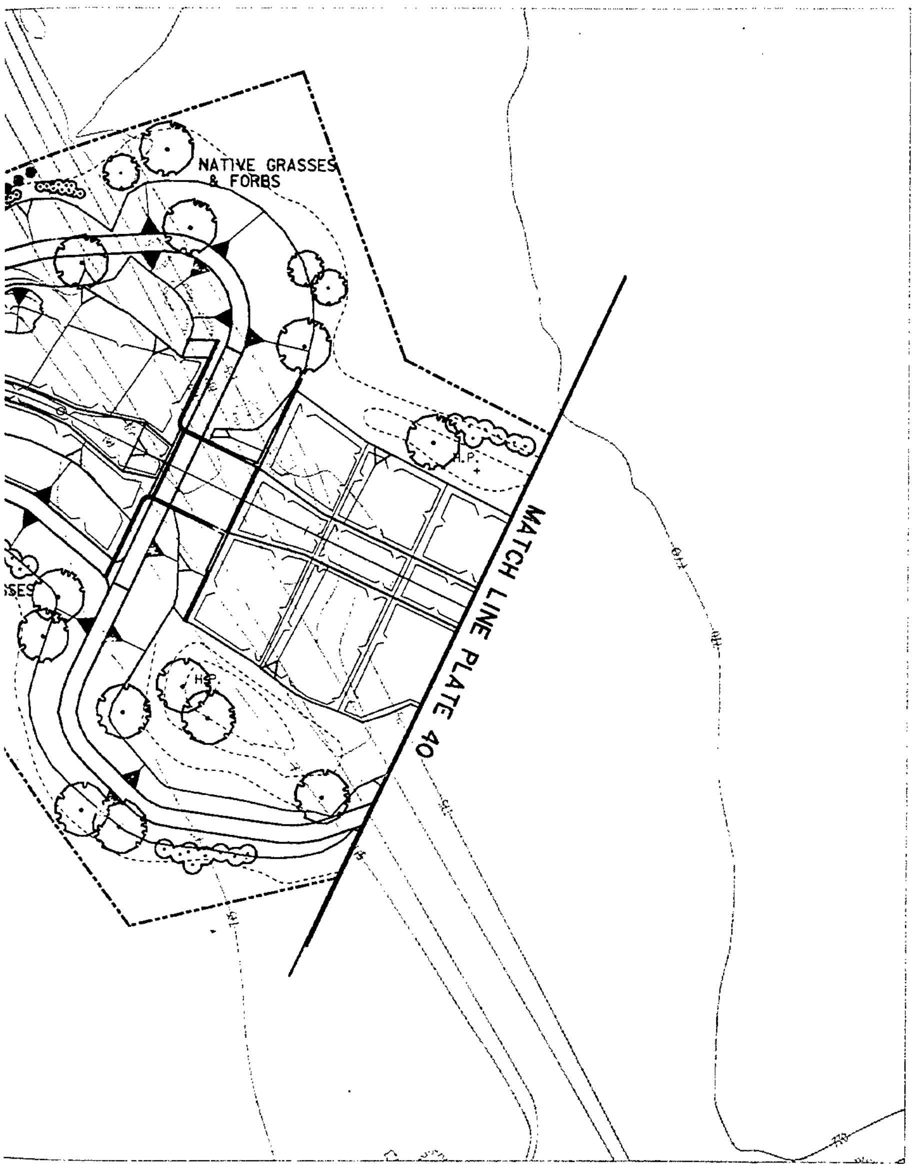
SHT 40 OF 43

2



EXISTING PEDESTRIAN PATH
FLOW
FLOW
NATIVE GRASSES & FORBS
PLAN
50 0 50 100
SCALE IN FEET

(1)



KEY

- FENCE
- RAILING
- EXISITNG VEGETATION
- EXISITNG TREE
- SHADE TREE
- ORNAMENTAL TREE
- CONIFEROUS TREE
- SHRUB MASSING

REFERENC.S:		PLATE NO.
1.	LOCATION, VICINITY MAP, & DRAWING SCHEDULE	1
2.	GENERAL PLAN	2
3.	PLAN & PROFILE	8
4.	LANDSCAPE DERAILS	42, 43

NOTES:

1. QUANTITY AND PLACEMENT OF OVERBUILD WILL COMPLY WITH CRITERIA SET FORTH IN EM 1110-2-301, 31 MARCH 1993.
2. PLACEMENT OF PLANTINGS AT LEVEES WILL COMPLY WITH CRITERIA SET FORTH IN EM 1110-2-301, 31 MARCH 1993.

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

ED-D	DESIGNED:	DMS
	CHECKED:	
	DRAWN:	DMS/EMH
ED-CH	DESIGNED:	
	CHECKED:	
DATE:	DECEMBER 1993	

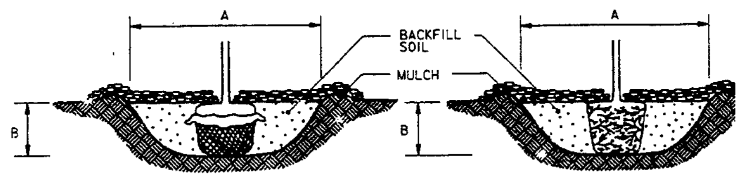
DESIGN MEMORANDUM
CHASKA - STAGE III
EAST CREEK
CHASKA PROJECT — CHASKA, MINNESOTA

FLOOD CONTROL
LANDSCAPE PLAN
STA. 50+00 TO 60+93

CAD FILE NAME: DPL6.DGN
SPEC NO:
DRAWING NUMBER: PLATE 41
SHT 41 OF 43

PLANTING HOLE DIMENSIONS

PLANT TYPE	PLANT SIZE (UP TO AND INCLUDING)	MINIMUM HOLE WIDTH (INCHES) A	APPROXIMATE HOLE DEPTH (INCHES) B
EVERGREEN TREES	4' B.B.	51	13
	6' B.B.	66	15
SHADE &	1 3/4" B.B.	72	16
ORNAMENTAL TREES	2" B.B.	72	16
	2 1/2" B.B.	84	19
	All Clump	114	23
SHRUBS	18" B.B.	27	7
	2' B.B.	30	8
	3' B.B.	36	9
	24" POT	36	13



BALLED & BURLAPPED STOCK

1. SCARIFY SIDES AND BOTTOM OF HOLE.
2. PROCEED WITH CORRECTIVE PRUNING AS DIRECTED BY THE CONTRACTING OFFICER.
3. SET PLANT ON UNDISTURBED NATIVE SOIL, OR THOROUGHLY COMPACTED BACKFILL SOIL AT THE SAME DEPTH AS IT WAS GROWN IN THE NURSERY.
4. PLANT SHALL BE PLACED IN PLANTING HOLE WITH BURLAP AND WIRE BASKET, IF USED, INTACT. ONCE IN PLACE, THE PLANT SHALL BE BACKFILLED TO WITHIN 12" OF THE TOP OF THE ROOTBALL. THE BURLAP SHALL BE FOLDED OR CUT BACK.
5. PLUMB AND BACKFILL WITH THE BACKFILL SOIL SPECIFIED.
6. BACKFILL VOIDS AND CONSTRUCT 3" DEPTH WATERING BASIN.
7. WATER THOROUGHLY WITHIN 2 HOURS.
8. PLACE MULCH WITHIN 48 HOURS OF THE SECOND WATERING.

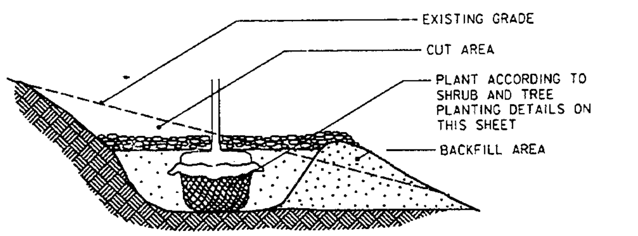
CONTAINER STOCK

1. SCARIFY SIDES AND BOTTOM OF H
2. PROCEED WITH CORRECTIVE PRUNI AS DIRECTED BY THE CONTRACTIN
3. REMOVE CONTAINER AND SCORE OU OF SOIL MASS TO REDIRECT CIRCI FIBROUS ROOTS AS NECESSARY.
4. SET PLANT ON UNDISTURBED NATI SOIL, OR THOROUGHLY COMPACTED BACKFILL SOIL AT THE SAME DEP AS IT WAS GROWN IN THE NURSER
5. BACKFILL VOIDS AND CONSTRUCT 3" DEPTH WATERING BASIN.
6. WATER THOROUGHLY WITHIN 2 HOU
7. PLACE MULCH WITHIN 48 HOURS O THE SECOND WATERING.

NOTES:

1. THE PLANTING DETAILS REPRESENT ADEQUATELY DRAINED SOIL CONDITIONS. THE CONTRACTOR SHOULD EXERCISE DISCRETION IN SETTING PLANTS 1"-3" HIGHER IN POORLY DRAINED SOILS.
2. ON 2:1 SLOPES OR GREATER, DO NOT CONSTRUCT THE UPHILL HALF OF THE WATERING BASIN.
3. ON WET, POORLY DRAINED SOILS, DO NOT CONSTRUCT WATERING BASIN.
4. THE CONTRACTOR SHALL BE RESPONSIBLE FOR PROVIDING ADEQUATE DRAINAGE IN HEAVY, POORLEY DRAINED OR IMPERVIOUS SOILS.

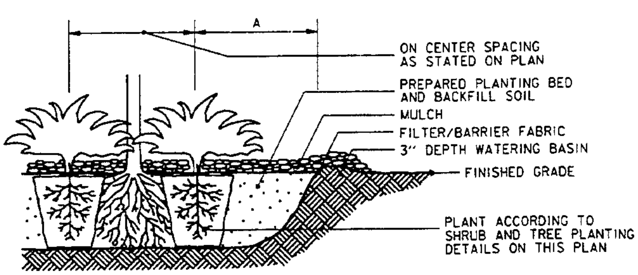
SHRUB AND TREE PLANTING DETAILS



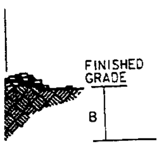
NOTE: EXTEND EXCAVATION AND BACKFILL SOIL TO A POINT DOWNSLOPE EQUAL TO OR LOWER IN ELEVATION THAN THE BOTTOM OF THE HOLE DIRECTLY BENEATH THE PLANT TO INSURE ADEQUATE DRAINAGE IN HEAVY SOILS. GRANULAR SOIL SHALL BE ADDED AS BACKFILL IN AREAS OF POOR DRAINAGE.

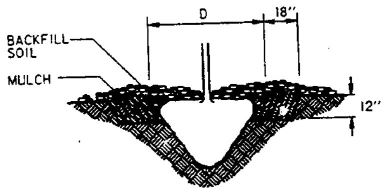
PLANTING ON A SLOPE

MASTE			
KEY	QTY	SIZE/ROOT	COMMON NAME
TREES			
ORNAMENTAL TREES			
SHRUBS			



TREE / SHRUB / GROUNDCOVER MASS BED PLANTING DETAIL





MACHINE-TRANSPLANTED STOCK (TREE SPADE)

1. SCARIFY SIDES AND BOTTOM OF HOLE.
2. SET PLANT ON UNDISTURBED NATIVE SOIL AT SAME DEPTH AS IT WAS PREVIOUSLY GROWN.
3. PLUMB AND BACKFILL WITH THE BACKFILL SOIL SPECIFIED, FILLING ALL VOIDS.
4. AFTER PLANTING, THE SOIL IMMEDIATELY ADJACENT TO THE SPADE MOVED SOIL, FOR A MINIMUM DISTANCE OF 18" SHALL BE TURNED OVER AND/OR ROTOTILLED TO A MINIMUM DEPTH OF 12".
5. CONSTRUCT 3" DEPTH WATERING BASIN.
6. WATER THOROUGHLY WITHIN 2 HOURS.
7. PLACE MULCH WITHIN 48 HOURS OF THE SECOND WATERING.

OF HOLE.
RUNING
.CTING OFFICER.
RE OUTSIDE
CIRCLING
RY.
NATIVE
ICTED
. DEPTH
JRSERY.
RUCT
2 HOURS.
JRS OF

:TOR
ILS.
ISIN.

MINIMUM TREE SPADE SIZE REQUIREMENTS			
SPADE SIZE (DIAMETER) 'D'	OAK TREES (CALIPER)	DECIDUOUS TREES (CALIPER)	EVERGREEN TREES (HEIGHT)
42"	1.0" to 1.5"	2" to 3"	5' to 7'
60"	1.5" to 2.5"	3" to 4"	7' to 9'
78"	2.5" to 3.5"	4" to 6"	9' to 14'
85"	3.5" to 5.0"	6" to 8"	14' to 18'

GENERAL NOTES

SEE CONTRACT SPECIFICATIONS FOR SPECIFIC PROJECT REQUIREMENTS

PLANTING BED PREPARATION: ALL MASS PLANTING BEDS SHALL BE TILLED TO A MINIMUM DEPTH OF 10". AMENDMENTS SHALL BE APPLIED AFTER CULTIVATION.

BACKFILL SOIL: USE SOIL EXCAVATED FROM PLANTING HOLES AND PROVIDE AMENDMENTS. REMOVE ALL DEBRIS INCLUDING ROCKS LARGER THAN 3" IN ANY DIMENSION.

FERTILIZER: FED. SPEC. 0-F-241 TYPE I (SOLID FORM) CLASS 2

SOIL AMENDMENTS AND CONDITIONERS: SEE CONTRACT SPECIFICATIONS.

MULCH MATERIAL: UNLESS OTHERWISE SPECIFIED, MASS MULCH ALL PLANTING BEDS.

TREE STAKING: Mn/DOT 2571.3J. SEE CONTRACT SPECIFICATIONS. TREE STAKING (ALL SIZES) WILL NOT BE REQUIRED UNLESS NECESSARY TO MAINTAIN TREES IN A PLUMB CONDITION WHERE VANDALISM, SOIL, OR WIND CONDITIONS ARE A PROBLEM.

MASS PLANTINGS: PLANT SPACING OF 5' OR LESS SHALL BE MASS EXCAVATED AND/OR CULTIVATED BY TILLING. PLANT IN STAGGERED ROWS ON THE PERIMETER FIRST, THEN UNIFORMLY FILL IN WITH REMAINING QUANTITY USING TRIANGULAR SPACING. PROVIDE 5' RADIUS CLEAR OF SHRUBS AROUND EACH DECIDUOUS TREE AND 8' RADIUS AROUND EACH EVERGREEN TREE. NOTIFY CONTRACTING OFFICER OF GROSS PLANT QUANTITY SURPLUS OR DEFICIENCY IMMEDIATELY. PLANT SPACINGS OF 5' OR LESS SHALL BE MASS MULCHED.

PLANTING PLAN: RESPECT STATED DIMENSIONS. DO NOT SCALE DRAWINGS.

WATERING GUIDELINES:

PLANT TYPE	AVERAGE AMOUNT OF WATER PER APPLICATION (GALLONS)
MACHINE TRANSPLANTED TREES (3" CALIPER+)	50-100
BALLED & BURLAPPED TREES	20+
BALLED & BURLAPPED SHRUBS	10

MASTER PLANT LIST

	BOTANICAL NAME

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

DESIGN MEMORANDUM
CHASKA - STAGE III
EAST CREEK

CHASKA PROJECT
CHASKA, MINNESOTA

FLOOD CONTROL

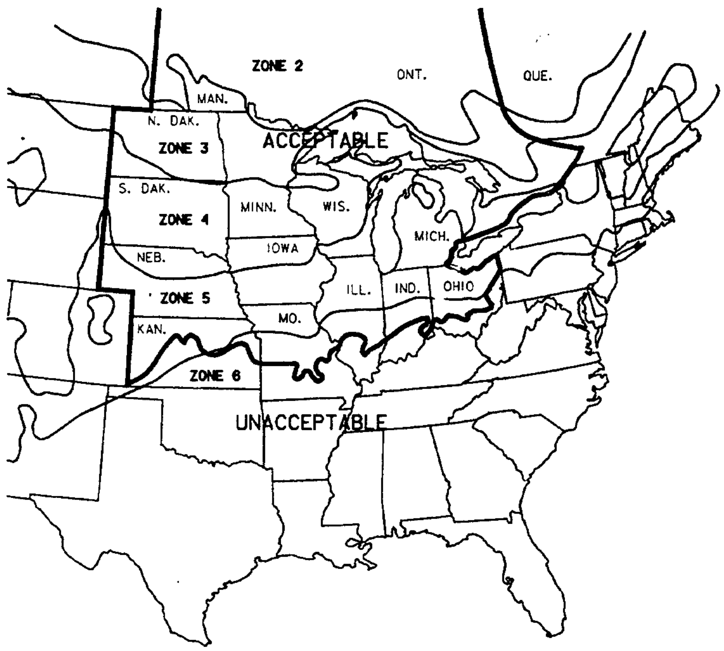
LANDSCAPE PLAN
PLANTING DETAIL

ED-D	DESIGNED:	DMS/
	CHECKED:	
	DRAWN:	DMS/
ED-GH	DESIGNED:	
	CHECKED:	

DATE: DECEMBER, 1994

CAD FILE NAME: c3detall.DGN
SPEC NO:
DRAWING NUMBER: PLATE 42
SHT 42 OF 43

2



ZONE 1	▭	BELOW -50 F
ZONE 2	▭	-50 to -40
ZONE 3	▭	-40 to -30
ZONE 4	▭	-30 to -20

PLANTS WITHIN THESE ZONES FROM THE ACCEPTABLE GROWING RANGE MAY BE USED ON ALL PROJECTS UNLESS OTHERWISE SPECIFIED.

ZONE 5	▭	-20 to -10

PLANTS WITHIN THIS ZONE FROM THE ACCEPTABLE GROWING RANGE ARE ALLOWED ONLY ON PROJECTS WITHIN ZONE 4.

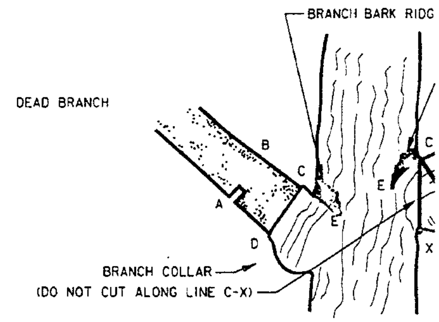
ACCEPTABLE GROWING RANGES FOR PLANT STOCK

SOURCE: U.S.D.A. PLANT HARDINESS ZONE MAP

SPRING		FALL	
DECIDUOUS	EVERGREEN	DECIDUOUS	EVERGREEN
APRIL 1 TO MAY 25	APRIL 1 TO MAY 15	OCT. 15 TO NOV. 20	SEPT. 5 TO OCT. 1

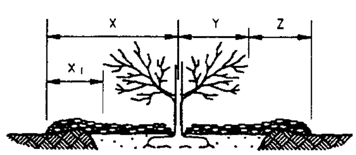
NOTE:
ACTUAL DATES MAY CHANGE DEPENDING UPON SEASONAL CONDITIONS AS DETERMINED BY THE CONTRACTING OFFICER.

OPTIMUM PLANTING DATES



FIRST CUT PART WAY THROUGH THE BRANCH AT "A" THEN CUT IT OFF AT "B". MAKE THE FINAL CUT AT "C"-"D' IF "D" IS HARD TO FIND: DROP A LINE FROM POINT "C"-- THE ANGLE FORM XCE=THE ANGLE FROM XCD.

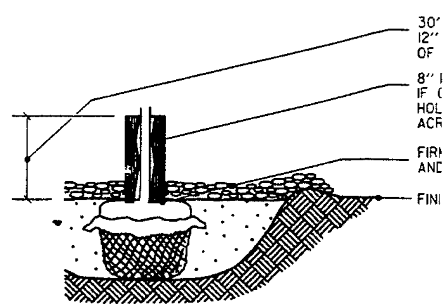
PRUNING DETAIL (Shigo Method)



NOTE: REMOVE MULCH PLACED TO A DEPTH GREATER THAN THAT SPECIFIED WHEN DIRECTED BY THE CONTRACTING OFFICER.

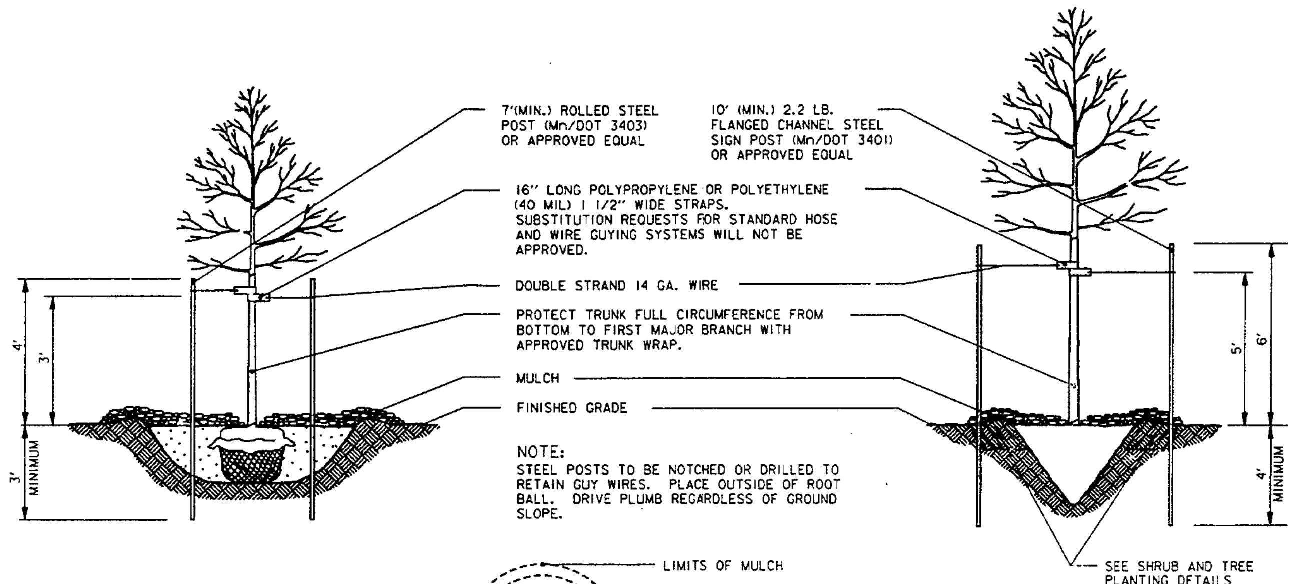
TYPE OF PLANT	X CENTER OF PLANT TO MULCH LINE	X 1 EDGE OF BRANCHING TO MULCH LINE	Y DEPTH OF MULCH	Z DEPTH OF MULCH
DECIDUOUS TREES	3' MIN.	N/A	6"	6"
EVERGREEN TREES	VARIES	3' MIN.	6"	6"
DECIDUOUS SHRUBS	3' MIN.	N/A	6"	6"
MACHINE-TRANSPLANTED TREES	12" BEYOND EDGE OF HOLE		6"	6"

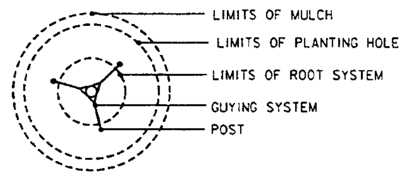
MULCH PLACEMENT DETAIL



NOTES:
1. DO NOT CUT LOWER BRANCHES TO PER
2. PLACE MULCH INSIDE CYLINDER TO SAM
3. INSTALLATION UNLESS OTHERWISE DIREC

RODENT PROTECTION DETAIL

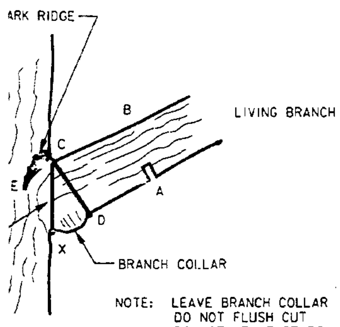




STANDARD TREE STAKING AND TRUNK PROTECTION DETAIL

TYPICAL PLAN VIEW

LARGE TREE STAKING AND TRUNK PROTECTION DETAIL



NOTE: LEAVE BRANCH COLLAR
DO NOT FLUSH CUT
DO NOT LEAVE STUBS

"C"-"D".

30" MIN. FOR DECIDUOUS TREES
12" MIN. FOR EVERGREEN TREES OR TO BOTTOM WHORL OF BRANCHES IF LESS THAN 12".

8" MIN. DIAMETER PERFORATED DRAIN TILE CYLINDER. IF CYLINDER IS PROVIDED WITHOUT PERFORATIONS, 3/8" HOLES MUST BE DRILLED AT 6" SPACINGS CONTINUOUS ACROSS LENGTH AND CIRCUMFERENCE OF CYLINDER.

FIRMLY ANCHOR CYLINDER BOTTOM IN SOIL AND MULCH WITHOUT DISTURBING TREE ROOTS.

FINISHED GRADE

TO PERMIT PROTECTION.
TO SAME DEPTH AS OUTSIDE.
E DIRECTED BY THE CONTRACTING OFFICER.

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:	DESIGN MEMORANDUM CHASKA - STAGE III EAST CREEK
ED-D DESIGNED: DMS/	CHASKA PROJECT — CHASKA, MINNESOTA
ED-D CHECKED:	FLOOD CONTROL
ED-D DRAWN: DMS/	LANDSCAPE PLAN PLANTING DETAIL
ED-GH DESIGNED:	
ED-GH CHECKED:	CAD FILE NAME: c3detail2.DGN — DRAWING NUMBER: — SHT 43
DATE: DECEMBER, 1994	SPEC NO: — PLATE 43 — OF 43

2

DRAFT

FINDING OF NO SIGNIFICANT IMPACT
AND
ENVIRONMENTAL ASSESSMENT

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
190 FIFTH STREET EAST
ST. PAUL, MINNESOTA 55101-1638

REPLY TO
ATTENTION OF

Environmental Resources Branch
Planning Division

DRAFT

FINDING OF NO SIGNIFICANT IMPACT

In accordance with the National Environmental Policy Act, the St. Paul District, Corps of Engineers, has assessed the environmental impacts of the following project:

DESIGN CHANGES TO
CHASKA FLOOD CONTROL PROJECT - STAGE 3
CHASKA, MINNESOTA

The intent of the proposed changes is to provide protection to Chaska from flooding along East Creek in the most cost efficient and environmentally acceptable manner. The design change involves the selection of an alternate East Creek diversion channel alignment. The proposed alignment is substantially different from what was selected in 1985, but is very similar to the design that was recommended in 1982. The project is described in Section 3.00 of the assessment. This Finding of No Significant Impact is based on the following factors: the effects of the proposed design change would not differ substantially from what was described for the East Creek diversion feature in earlier NEPA documents; the changes would not require additional fish and wildlife mitigation features; the project would have no impact on the cultural environment; and continued coordination will be maintained with appropriate State and Federal agencies. See sections and 1.00 and 5.00 of the assessment for a discussion of the impacts.

The environmental review process indicates that the proposed action does not constitute a major Federal action significantly affecting the environment. Therefore, an environmental impact statement will not be prepared.

James T. Scott
Colonel, Corps of Engineers
District Engineer

____
Date

DRAFT

ENVIRONMENTAL ASSESSMENT
DESIGN CHANGES TO THE
CHASKA FLOOD CONTROL PROJECT - STAGE 3
CHASKA, MINNESOTA

U.S. Army Corps of Engineers
St. Paul District

DRAFT
ENVIRONMENTAL ASSESSMENT
DESIGN CHANGE TO THE
CHASKA FLOOD CONTROL PROJECT - STAGE 3
CHASKA, MINNESOTA

1.00 SUMMARY

1.01 The Water Resources Development Act of 1976 (Public Law 94-587) authorized the proposed flood control project at Chaska, Minnesota. The plan consists primarily of upgrading and extending an existing levee system along the Minnesota river, diverting the flow of Chaska Creek to the outside of the leveed area, and diverting the flood flow of East Creek to the outside of the leveed area. Fish and wildlife mitigation features include plantings on project lands, the construction of a moist soil unit, and the construction of an outlet/control structure for Chaska Lake. The moist soil unit and Chaska Lake outlet would be constructed on the Minnesota Valley National Wildlife Refuge. The plan is described in the Limited Reevaluation Report for the project dated August 1982. A Final Environmental Impact Statement for the project was filed in 1976. A Supplement to the Final EIS and 404(b)(1) evaluation was completed in 1982. A proposed change to the East Creek diversion feature of the project required the preparation of a Supplement II to the Final EIS, which was completed in 1985.

1.02 Implementation of the flood control project at Chaska is divided into four stages of construction. Advanced engineering and design studies for Stage 3, which involves the construction of the East Creek Diversion feature, has resulted in a change in the alignment of the diversion channel. The alignment is similar to what was presented in the 1982 Supplement to the Final EIS. This assessment was prepared to address the impacts of the currently proposed alignment.

1.03 An environmental review of the proposed changes indicates that they would not result in significant adverse effects to the environment. Therefore, a supplement to the EIS will not be prepared. Should public review of this EA identify significant concerns, a revised NEPA document may be prepared. A 404(b)(1) evaluation for the project was completed and submitted to Congress in 1982. Fill activities associated with the proposed design would not differ substantially from what was presented in the 1982 evaluation. Therefore, a revised 404(b)(1) evaluation will not be prepared.

Relationship to Environmental Requirements

1.04 The proposed activities would be in compliance with all applicable Federal environmental laws. Executive Orders and policies, and State and local laws and policies including the Clean Air Act, as amended; the Clean Water Act of 1977; the Endangered Species Act, as amended; the Land and Water Conservation Fund Act of 1965, as amended; the National Historic Preservation Act of 1966, as amended; the National Environmental Policy Act of 1969, as amended; the Fish and Wildlife Coordination Act of 1958, as amended; Executive Order 11988-Floodplain Management; and Executive Order 11990-Protection of Wetlands. The project reach

is located within the corporate limits of Chaska and is zoned for residential and commercial development. Therefore, the provisions of the Farmland Protection Policy Act of 1981 do not apply.

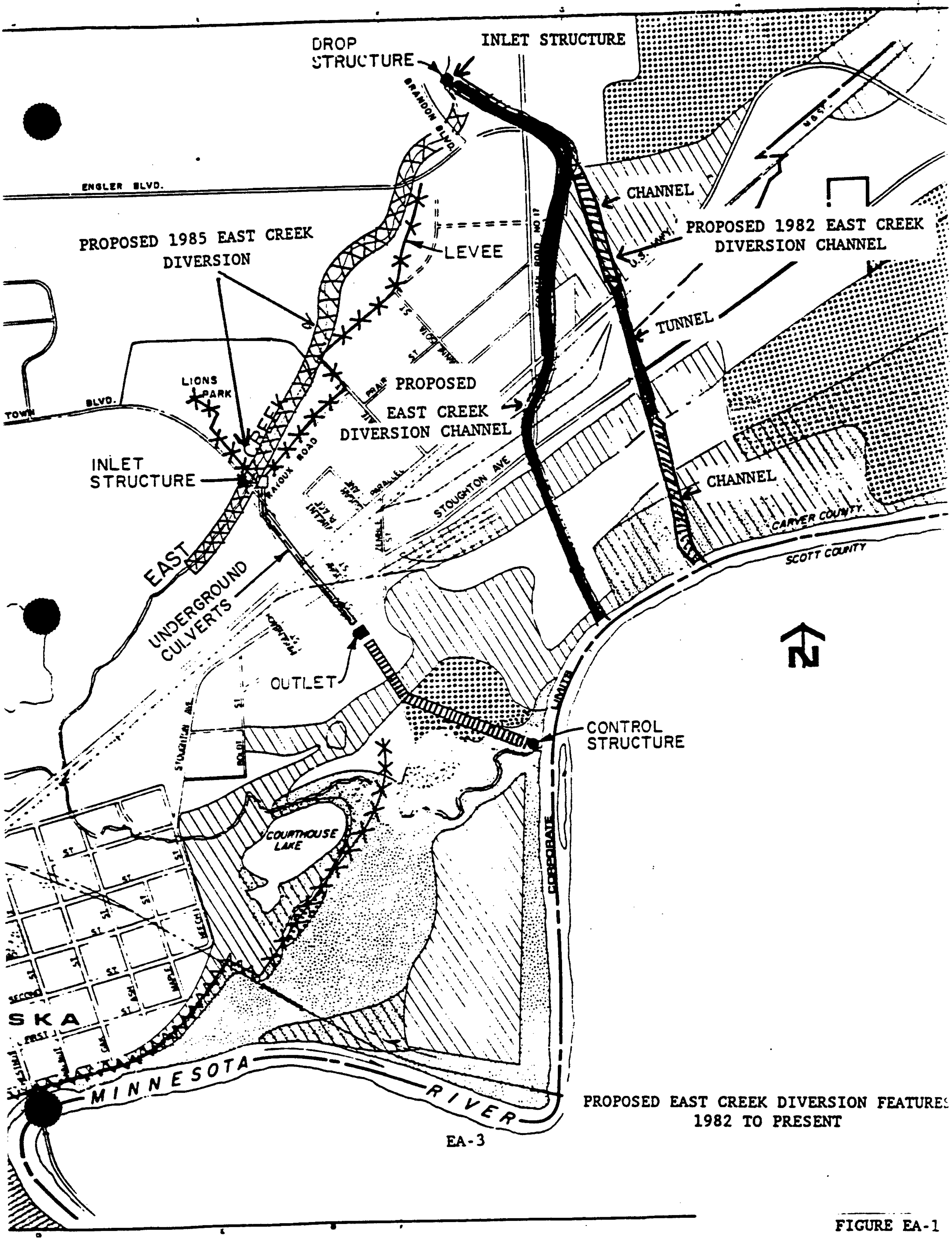
2.00 NEED FOR AND OBJECTIVES OF ACTION

2.01 The Water Resources Development Act of 1976 (Public Law 94-587) authorized the proposed flood control project as Chaska, Minnesota. A Final EIS for the project was filed in 1976. Postauthorization studies reanalyzed the authorized plan in view of updated study area information and new technical and environmental criteria. The Limited Reevaluation Report and Final Supplement to the Environmental Impact Statement, which included a 404(b)(1) evaluation, was completed in 1982. That document identified the need for fish and wildlife mitigation for unavoidable losses due to construction. Mitigation features include the planting of vegetation on project lands to provide wildlife habitat, and the construction of fish and wildlife features on the Minnesota Valley National Wildlife Refuge. The features include the construction of an outlet control structure for Chaska Lake and the construction of a moist soil unit just to the east of Chaska Lake. The outlet control structure will provide the capability to manipulate water levels on the lake to control aquatic vegetation. The moist soil unit will be managed to provide feeding habitat for waterfowl. Design changes to the East Creek feature of the project, which consisted of a major change in the location of the diversion channel, required the preparation of a Supplement II to the Final EIS in 1985. While additional mitigation was not recommended at that time, the Supplement II stated that detailed design studies of the revised plan may indicate the need for additional mitigation.

2.02 Implementation of the flood control project at Chaska is divided into four stages of construction. Work scheduled for Stage 3 consists of the construction of a diversion structure in East creek and the construction of a diversion channel that would convey flood flows to the Minnesota River. The present channel design and alignment is similar to what was presented in the 1982 Supplement to the Final EIS , but is substantially different from the selected plan that was discussed in the 1985 Supplement II to the Final EIS (Figure EA-1). This assessment is being prepared to address the effects of the proposed design. The proposed design would not require a substantial change in fill activities from what was presented in the 404(b)(1) evaluation prepared in 1982. Therefore a revised 404(b)(1) evaluation will not be prepared.

3.00 ALTERNATIVES

3.01 Alternatives to the proposed project were evaluated in the Final EIS and subsequent supplements. Proposed channel alignments for the East Creek Feature were also evaluated in these documents. The proposed changes in channel alignment and design for the East Creek Diversion are a result of the 1989 East Creek Value Engineering Study that was done to investigate ways to reduce the cost of this feature. The proposed design is a result of that effort and previously evaluated diversion alignments were not restudied. Only one other alternative was reconsidered at the request of the City of Chaska.



PROPOSED EAST CREEK DIVERSION FEATURES
1982 TO PRESENT

FIGURE EA-1

Plans Eliminated from Further Study

3.02 The City of Chaska indicated that they would prefer that an alternative diverting flood flows down an existing creek, known as Assumption Creek, be studied in more detail. This alternative was considered in 1982 and during the East Creek Value Engineering Study in 1989. The Minnesota Department of Natural Resources and the U.S. Fish and Wildlife Service indicated that the potential impacts with this alternative would be significant. Assumption Creek is designated by the Minnesota DNR as a native brook trout stream. The use of the headwaters of this creek as a ponding area and the attendant channel work that would be required would seriously degrade the suitability of the stream as brook trout habitat. In addition, several wetlands are located along Assumption Creek which would be adversely affected with this alternative. The selection of this alternative would most likely not be supported by natural resources agencies and would require additional mitigation features. Initial design studies also indicated that this alternative may also require extensive upgrading of an existing railroad embankment which would significantly increase the cost of this alternative. For these reasons this alternative was not considered in detail.

Selected Plan

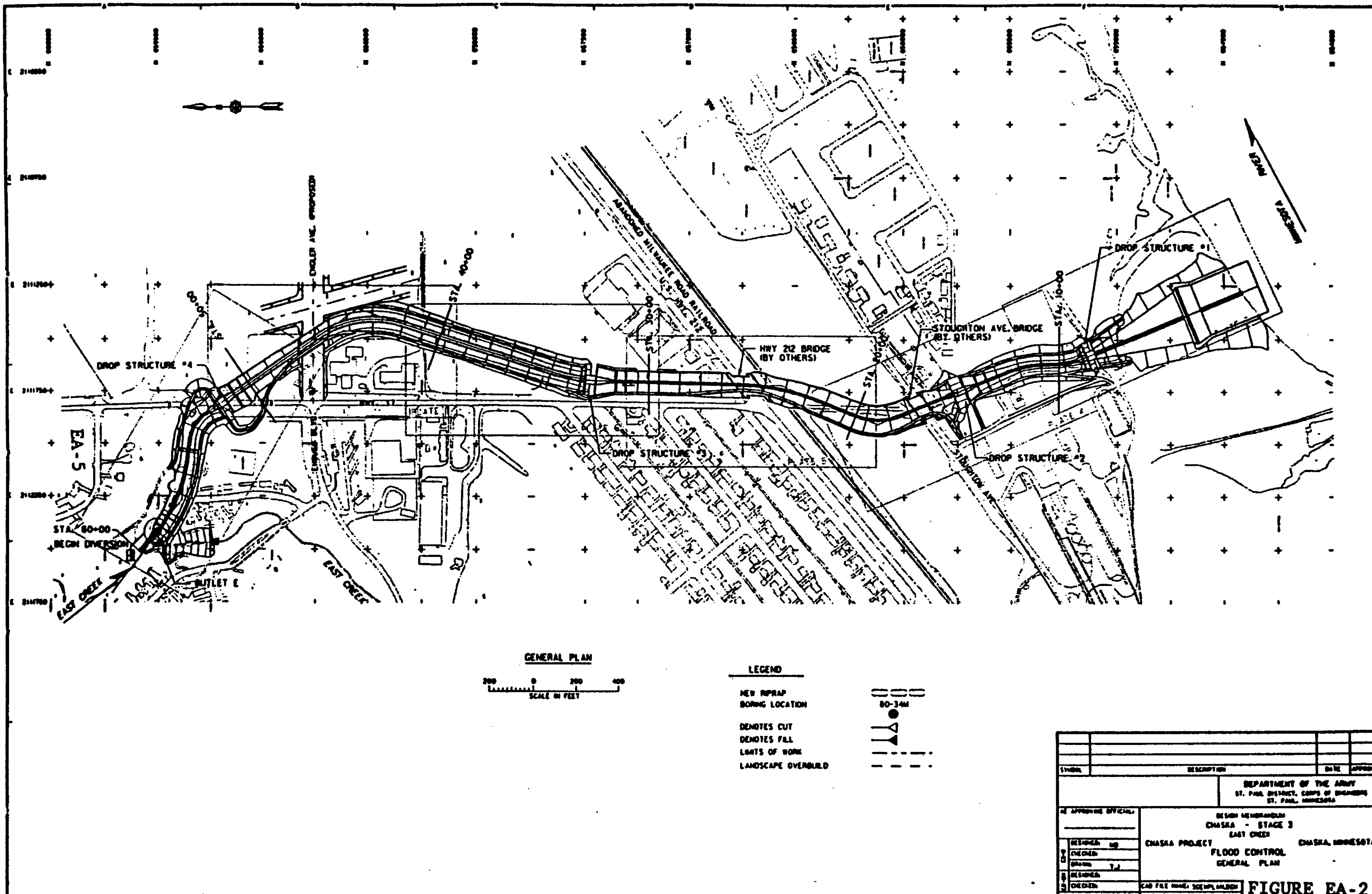
3.03 Work Scheduled for the East Creek Diversion includes the construction of a diversion structure at East Creek, a 5600-foot diversion channel and 3 drop structures (Figure EA-2). A recreation trail would be built along a portion of the diversion channel. Landscaping to provide wildlife habitat would also be done along portions of the diversion channel. Excess material excavated as part of the project would be placed in areas immediately adjacent to the channel. Any required fill material would come from existing commercial borrow facilities. Detailed information on these features is presented in the main report.

4.00 AFFECTED ENVIRONMENT

Natural Resources

4.01 Land use along this reach of the project is a mix of residential development, commercial development, undeveloped lands and cropland. The inlet of the diversion channel is located in a residential area that is primarily a trailer park. Most of the channel is located in open fields. Some light industrial development and a nursery are adjacent to the channel alignment on the upstream end. The lower 1,600 feet of the channel runs adjacent to the Crystal Sugar facilities. The floodplain of the Minnesota River is composed of a mix of riparian woods and floodplain wetlands. Riparian woods vegetation includes silver maple, American elm, box elder, cottonwood and willow with an understory of nettle, jewelweed and grasses.

4.02 A fen is located immediately to the east of the proposed channel. A fen is a type of wetland supported by groundwater discharge such as springs and seepages. The fen is about 5 acres in size and is fairly diverse in nature. During a recent survey four plant communities were identified within this fen: sedge meadow, shallow marsh, shrub-carr and lowland hardwood forest. The sedge meadow is dominated by tussock sedge and Canada bluejoint grass. Prairie sedge,


MINNESOTA RIVER
DROP STRUCTURE #1
STA. 10+00
STOUGHTON AVE. BRIDGE (BY OTHERS)
STOUGHTON AVE.
DROP STRUCTURE #2
HWY 212 BRIDGE (BY OTHERS)
ABANDONED MILWAUKEE ROAD RAILROAD
U.S. HWY. 212
STA. 30+00
DROP STRUCTURE #3
STA. 40+00
ENGLER AVE. (PROPOSED)
DROP STRUCTURE #4
STA. 50+00
STA. 60+00
BEGIN DIVERSION
OUTLET E
EAST CREEK
GENERAL PLAN
200 0 200 400
SCALE IN FEET
LEGEND
NEW RIPRAP
BORING LOCATION
80-34M
DENOTES CUT
DENOTES FILL
LIMITS OF WORK
LANDSCAPE OVERBUILD
SYMBOL
DESCRIPTION
DATE
APPROVAL
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA
DESIGN MEMORANDUM
CHASKA - STAGE 3
EAST CREEK
CHASKA PROJECT
CHASKA, MINNESOTA
FLOOD CONTROL
GENERAL PLAN
DESIGNED
CHECKED
DRAWN
DATE
FIGURE EA-2

marsh fern, asters and goldenrods are also present. The shallow marsh is dominated by lake sedge, cattail and reed canary grass, with marsh marigold and jewelweed as common forbs. The shrub-carr is dominated by willows and the lowland hardwoods are typical of riparian woods in the area.

4.03 As noted in the Final Supplement II to the EIS, no federally-listed or state-listed threatened or endangered species are present in the project area. The Higgins' eye pearly mussel (Lampsilis higginsi) has been extirpated from the lower Minnesota River. The peregrine falcon (Falco peregrinus) and the bald eagle (Halaeetus leucocephalus) may occasionally be sighted in the area during migration.

4.04 An Environmental Site History was conducted for the proposed channel alignment to assess the potential of encountering contaminated soils during construction (Supplement 3 to the General Design Memorandum). A review of insurance maps, directories, aerial photos, data bases and a site survey did not indicate any potential for contaminated soils along the channel alignment.

Cultural Resources

4.05 In accordance with Section 106 of the National Historic Preservation Act of 1966, as amended, the National Register of Historic Places has been consulted. A standing structure survey of Carver County conducted for the Minnesota State Historic Preservation Office in 1978 recorded 23 historic National Register buildings and one National Register district in the city of Chaska. As of 1 July 1992, there are no sites listed on or eligible for inclusion on the National Register that will be affected by the proposed Stage 3 East Creek diversion channel. The trailer houses to be removed are all less than 50 years old. The private residences to be removed have been evaluated as being not eligible for listing on the National Register. As a result, there will be no effect on significant historic properties if any of these buildings are removed as proposed.

4.06 The Stage 3 diversion channel alignment was surveyed for cultural resources in 1991 in conjunction with a survey of the Stage 4 levee alignment and moist soil unit. No cultural resources were encountered along the Stage 3 alignment either on the surface or below it in power auger tests drilled to a maximum depth of 8 meters (ca. 26 feet). The Minnesota State Historic Preservation Office concurs that "no properties eligible for or listed on the National Register of Historic Places are within the project's area of potential effect" (letter from MN SHPO dated December 16, 1991).

4.07 The proposed Stage 4 borrow area, which may be used for Stage 3, has likewise been cleared from a cultural resources standpoint. A cultural resources survey of the Kusske borrow pit during April 1992 encountered only one small chipped stone flake from the plowzone during shovel testing. Based on the results of the survey, the Minnesota State Historic Preservation Office has concluded that "no properties eligible for or listed on the National Register of Historic Places are within the project's area of potential effect" (letter from MN SHPO dated May 26, 1992).

5.00 ENVIRONMENTAL EFFECTS

5.01 An environmental analysis has been conducted for the proposed design change to the East Creek Diversion feature, and a discussion of those impacts is presented below. The discussion addresses only the effects of the proposed design changes and how they would differ from those discussed in previous NEPA documents. As specified in Section 122 of the 1970 Rivers and Harbors Act, the categories of impacts listed in table EA-1 were reviewed and considered in arriving at the final determination.

Natural Resources

5.02 The impacts of the proposed channel alignment and design would not differ substantially from what was described for the East Creek diversion feature in earlier NEPA documents. Construction of the proposed features would result in the loss of approximately 3 acres of grassland, 8 acres of cropland and 3 acres of wooded areas. About 1.5 acres of the woodlands that would be affected are riparian, and would be lost with the construction of the outlet at the Minnesota River. Previous designs would have resulted in the loss of up to 6 acres of riparian woods. Habitat losses to wildlife with project construction were partially mitigated with the planting of upland vegetation on project lands in conjunction with the construction of stage 2 along Chaska Creek. Shrubs and shrubby tree species such as dogwood, hazel and russian olive along with oak, wildplum, chokecherry, maple and ash were planted and will be managed for wildlife.

5.03 The outlet for the diversion channel is routed through an old lime settling pond that was used in the processing of sugar beets. The pond is now abandoned and is filled to a height of about 15 feet with lime. The lime is periodically mined by the current owners and sold to the surrounding agricultural community for soil adjustment. The channel alignment from 0.00 to 15.00 was selected to avoid the fen complex immediately to the east of the proposed channel and to minimise impacts on riparian woodlands. The bottom elevation of the diversion channel in this reach was designed to help ensure that the hydrologic regime of the fen is not adversely affected by the diversion channel.

5.04 Mitigation for losses associated with construction of this and other stages of the project will be provided with the construction of fish and wildlife features on the Minnesota Valley National Wildlife Refuge. The features include the construction of an outlet control structure for Chaska Lake and the construction of a moist soil unit just to the east of Chaska Lake. The outlet control structure will provide the capability to manipulate water levels on the lake to control aquatic vegetation. The moist soil unit will be managed to provide feeding habitat for waterfowl. The area will be created by diking a 16 acre site that is currently cropland. The system will consist of two cells that can be flooded to a depth of about 2 feet and managed independently. This feature will be constructed concurrently with Stage 4 of the project.

Cultural Resources

5.05 As of 1 July 1992, there are no cultural resources sites listed on or

TABLE EA-1: Evaluation of impacts of Design Changes

MAGNITUDE OF PROBABLE IMPACT

IMPACT ASSESSMENT MATRIX NAME OF PARAMETER	<—— INCREASING BENEFICIAL IMPACT			NO APPRECIABLE EFFECT	INCREASING ADVERSE IMPACT ——>		
	SIGNIFICANT	SUBSTANTIAL	MINOR		MINOR	SUBSTANTIAL	SIGNIFICANT
A. SOCIAL EFFECTS							
1. Noise Levels				X			
2. Aesthetic Values				X			
3. Recreational Opportunities				X			
4. Transportation				X			
5. Public Health and Safety				X			
6. Community Cohesion (Sense of Unity)				X			
7. Community Growth & Development				X			
8. Business and Home Relocations				X			
9. Existing/Potential Land Use				X			
10. Controversy				X			
B. ECONOMIC EFFECTS							
1. Property Values				X			
2. Tax Revenues				X			
3. Public Facilities and Services				X			
4. Regional Growth				X			
5. Employment				X			
6. Business Activity				X			
7. Farmland/Food Supply				X			
8. Commercial Navigation				X			
9. Flooding Effects				X			
10. Energy Needs and Resources				X			
C. NATURAL RESOURCE EFFECTS							
1. Air Quality				X			
2. Terrestrial Habitat				X			
3. Wetlands				X			
4. Aquatic Habitat				X			
5. Habitat Diversity and Interspersion				X			
6. Biological Productivity				X			
7. Surface Water Quality				X			
8. Water Supply				X			
9. Groundwater				X			
10. Soils				X			
11. Threatened or Endangered Species				X			
D. CULTURAL EFFECTS							
1. Historic Architectural Values				X			
2. Pre-Hist & Historic Archeological Values				X			

eligible for inclusion on the National Register of Historic Places in the proposed Stage 3 construction area. A cultural resources survey in 1991 revealed no prehistoric or historic sites along the proposed East Creek diversion channel alignment. The Minnesota State Historic Preservation Office has concurred that the isolated flake found in the proposed Stage 3 and 4 borrow area is not eligible to the National Register of Historic Places. Therefore, no historic properties (per 36 CFR Part 800) will be affected by channel construction and use of the borrow area as proposed.

6.00 COORDINATION

6.01 Coordination with public and government agencies has been maintained. Coordination letters from the U.S. Fish and Wildlife Service (FWS) and the Minnesota Department of Natural Resources (MDNR) are included in exhibit 1.

6.02 The FWS recommended that impacts to the fen complex be avoided. The channel has been designed to avoid adverse impacts on this resource by the channel alignment and the elevation of the bottom of the channel. The FWS agrees with this approach. The FWS also recommended that plantings be included on project lands along the channel and to the use the guidelines that were presented in the 1981 Fish and Wildlife Coordination Act Report. These plantings are included in the project design. The Corps of Engineers agrees with the FWS recommendation that work activities in lowland hardwoods along the Minnesota River be minimized to the extent practicable.

6.03 The Corps recommended that the design of the moist soil unit be modified to facilitate the construction of the moist soil unit and to avoid impacts on areas that revegetated since the plan was originally proposed in 1982. The FWS agreed with this proposal.

6.04 The MDNR agreed with the recommendations of the FWS. No additional concerns were identified by the MDNR.

6.02 The Minnesota State Historic Preservation Office has been coordinated with regarding cultural resources along the proposed Stage 3 channel alignment and use of the Kusske borrow pit. The Minnesota State Historic Preservation Office has concurred that, based on the results of two cultural resources surveys, there are no significant historic properties in these areas.

6.03 The draft environmental assessment will be sent to interested citizens and the following agencies:

<u>Federal</u>

Department of Transportation
Environmental Protection Agency
U.S. Coast Guard
U.S. Fish and Wildlife Service
U.S. Geological Survey
National Park Service
Soil Conservation Service
Advisory Council on Historic Preservation

State of Minnesota

Department of Energy, Planning and Development
Department of Agriculture
Department of Health
Department of Natural Resources
Department of Transportation
Pollution Control Agency
State Archaeologist
State Historic Preservation Officer
Water Resources Board

Others

Mayor of Chaska
Chaska City Council
City Engineer, Chaska

EXHIBIT 1

CORRESPONDENCE

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Twin Cities Field Office
4101 East 80th Street
Bloomington, Minnesota 55425-1665

TAKE PRIDE IN AMERICA

IN REPLY REFER TO:
FWS AFWE-TCFO

SEP 10 1992

Colonel Richard Craig
District Engineer
U.S. Army Corps of Engineers
1421 U.S. Post Office and Custom House
St. Paul, Minnesota 55101-1479

Dear Colonel Craig:

This letter constitutes a supplemental report to the Final Fish and Wildlife Coordination Act Report dated December 1981, for the Chaska Flood Control Project in Chaska, Minnesota. The supplemental report was prepared at the request of the St. Paul District for revisions to the East Creek Diversion Channel component of the overall Chaska Project.

Background

On December 23, 1981, the U.S. Fish and Wildlife Service (Service) submitted a draft Fish and Wildlife Coordination Act (FWCA) Report to the St. Paul District Corps of Engineers for the Chaska Flood Control Project. This report, adopted by the Service on August 27, 1982, as the final FWCA report, was based on the findings of a habitat evaluation conducted by a tri-agency team of biologists representing the Minnesota Department of Natural Resources, U.S. Army Corps of Engineers, and Service. The tri-agency team's analysis was conducted in accordance with the Service's Habitat Evaluation Procedures (HEP) and Mitigation Policy. The FWCA report recommended measures to improve project lands for wildlife purposes, quantified project impacts to fish and wildlife resources, and recommended three alternative compensation proposals to replace unavoidable habitat losses. One of these proposals (Compensation Proposal A) involving construction of a water control structure on Chaska Lake and a moist soil management unit was subsequently selected by the Corps of Engineers for implementation as part of the overall Chaska Flood Control Project.

In 1984, the St. Paul District proposed a new alignment for the East Creek Diversion Channel component of the Chaska Project and requested Service review of the revision. In March 1984, the Service submitted a Draft Supplemental Report to the Final Fish & Wildlife Coordination Act Report on the revised East Creek Diversion Channel. The report evaluated the impacts to fish and wildlife habitats in comparison to the original alignment and provided a variety of recommendations to avoid and minimize habitat losses. In general, the revised alignment for the East Creek Diversion Channel would result in additional habitat losses in comparison to the original alignment and would require additional mitigation beyond the Compensation Plan, the extent of which would depend on project-related impacts to a large wetland area bisected by the channel.

In 1992, the St. Paul District has again revised the alignment for the East Creek Diversion Channel and has requested Service review of the changes. Preliminary information on the proposed alignment have been provided for Service review and comment. In addition, the project has been reviewed in the field by personnel from the Minnesota Department of Natural Resources, St. Paul District and Service. This supplemental report will compare habitat losses for the newly-revised East Creek Diversion Channel to the original alignment.

Revised East Creek Diversion Channel Alignment

Enclosure A provides a map showing the alignments for the original and newly-proposed East Creek Diversion Channel. In general, the revised alignment follows the original alignment in the upper reaches of the project. It then shifts to the east of the original alignment and follows County Road 7, eventually crossing Stoughton Road and terminating at the Minnesota River.

The upper reaches of the revised project involve essentially similar habitat losses (grassland/cropland) as the original alignment (10.5 acres for the original alignment and 11.0 acres for the revised alignment). The lower reaches of the project are substantially different, however. From Stoughton Road, the proposed diversion channel heads in a southeast direction towards the Minnesota River crossing upland woods, grassy areas, a former lime settling pond of the Crystal Sugar facility, and lowland hardwoods.

The lower reaches of the revised project will result in the loss of approximately 1.5 acres of upland woods and 1.5 acres of bottomland hardwoods. In comparison, the original alignment would have taken approximately 6.0 acres of bottomland hardwoods. Therefore, the revised alignment will result in fewer adverse impacts to wooded habitats (approximately 3.0 acres). Given the original Habitat Unit Value of 57 for Lowland Hardwoods, this change in habitat loss is 171 Habitat Units.

Recommendations

The following recommendations are provided for use by the St. Paul District and City of Chaska in implementing the revised East Creek Diversion Channel and remaining portions of the overall Chaska Flood Control Project:

1. The downstream segment of the revised East Creek Diversion Channel is located adjacent to a 5-acre wetland area. This wetland was recently surveyed by St. Paul District personnel and described as a Fen Complex. The Service recommends that all project-related impacts to this wetland area be avoided. In particular, the outlet of the wetland is located immediately adjacent to the proposed diversion channel. The project should be located and designed to avoid impacts to the existing hydrology of this wetland basin.

This report assumes that impacts to the Fen Complex will be avoided by the project. If this is not the case, then the St. Paul District should conduct studies to adequately assess project-related impacts to the Fen Complex. This information should be provided for review by the Service and used to quantify habitat losses and compensation requirements for this segment of the Chaska

Flood Control Project.

2. A planting plan should be developed and implemented by the St. Paul District and City of Chaska for project lands adjacent to the revised East Creek Diversion Channel. Recommendations contained in the 1981 FWCA Report should be used for guidance in developing the vegetation plan.

3. Work activities in lowland hardwoods adjacent to the Minnesota River should be minimized to the greatest extent possible.

4. As indicated previously, the revised project will result in fewer impacts to fish and wildlife habitats than the original alignment. This change in impacts is approximately 171 Habitat Units. The original Mitigation Plan adopted by the St. Paul District involving construction of a water control structure on Chaska Lake and 19-acre moist soil unit was designed to offset losses for the original project as described in 1981.

In order to credit the reduction in habitat losses, the Service recommends that the 19-acre moist soil unit be reduced in size by approximately 3.5 acres by realignment of the eastern boundary. This modification has been proposed to District personnel and is shown on Enclosure B. Doing so will reduce the overall Compensation Plan by approximately 140 Habitat Units.

<u>Summary</u>

The proposed alignment of the East Creek Diversion Channel will result in fewer impacts to valuable fish and wildlife habitats than the original alignment. However, this report assumes that project-related impacts to the 5-acre Fen Complex are avoided. If this is not the case, the St. Paul District should adequately assess impacts to the Fen Complex and provide this information to the Service for further assessment of project-related impacts for the East Creek Diversion Channel.

If additional impacts to the Fen Complex are avoided, the Service recommends that the Compensation Plan for the overall Chaska Flood Control Project be revised to give appropriate credit to the Corps and City of Chaska in reducing project-related impacts.

We appreciate the opportunity to offer our comments on the revised project. Please contact Mr. Gary Wege at 725-3548 if you have any questions on the contents of this report. These comments have been prepared under the

authority of the Fish and Wildlife Coordination Act (16 U.S.C. 661 et seq.), the National Environmental Policy Act of 1969 (42 U.S.C. 4321-4327), the Endangered Species Act of 1973, (16 U.S.C. 1531-1543), as amended, and the U.S. Fish and Wildlife Service's Mitigation Policy.

Sincerely,

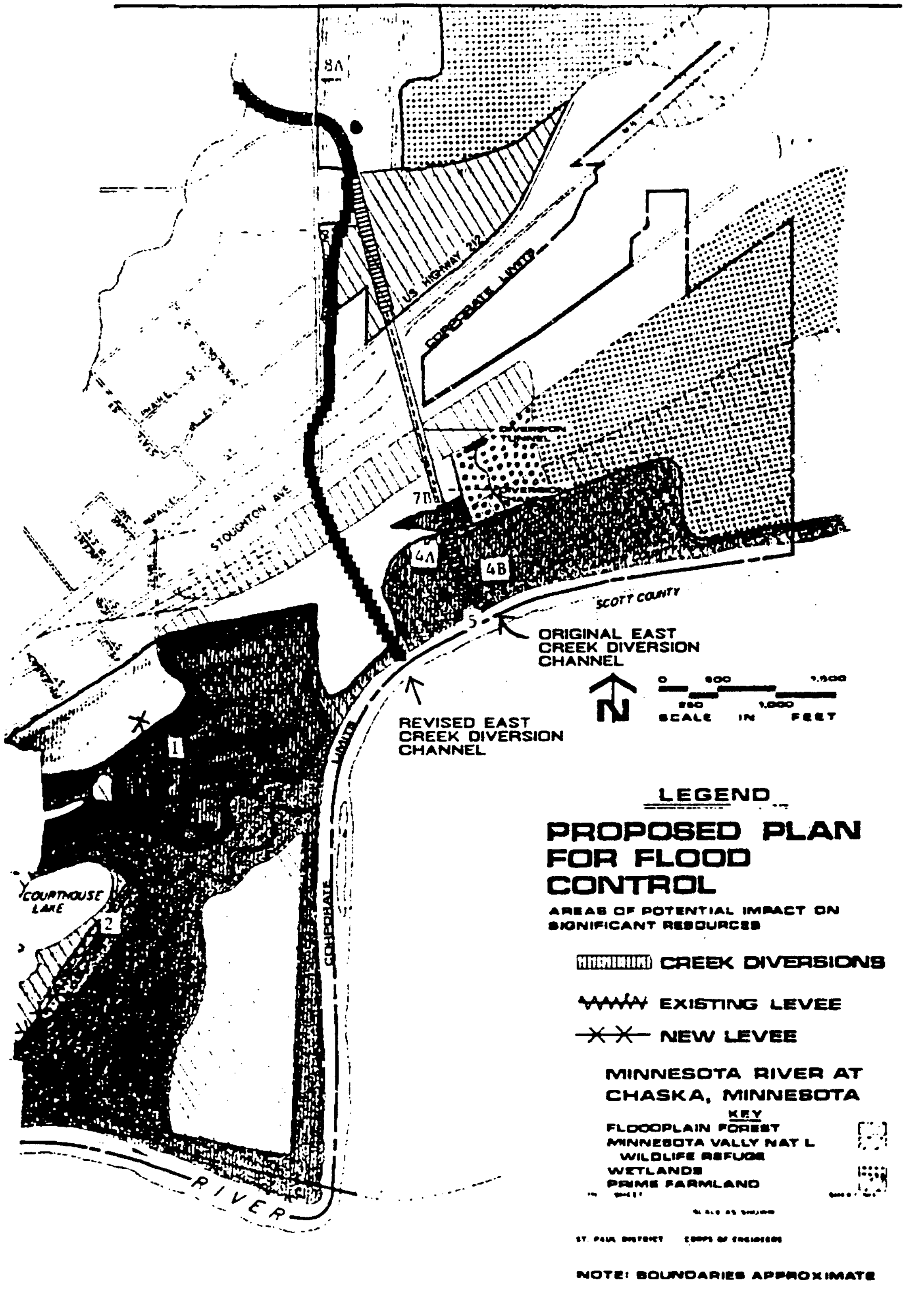
Lynn M. Lewis

Lynn M. Lewis
Field Supervisor

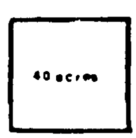
Enclosures

cc: Minnesota Department of Natural Resources, St. Paul, Minnesota
Minnesota Pollution Control Agency, St. Paul, Minnesota
City of Chaska, Minnesota

ATTACHMENT A



ATTACHMENT B



STATE OF
MINNESOTA
DEPARTMENT OF NATURAL RESOURCES

PHONE NO. FILE NO.

September 24, 1992

Colonel Richard Craig
District Engineer
U.S. Army Corps of Engineers
1421 U.S. Post Office and Custom House
St Paul, MN 55101-1479

Re: Chaska Flood Control Project, Final Fish and Wildlife Coordination Act Report, December 1981.

Dear Colonel Craig:

The Minnesota Department of Natural Resources (DNR) has completed a review of the proposed changes to the alignment of the East Creek Diversion Channel. The following comments are provided for your consideration.

We concur with USFWS position that the wet soil unit berm be constructed along the edge of the wooded/shrub area (approximately along the existing field road) and not in the wooded/shrub area.

We also support the USFWS recommendation that the downstream segment of the revised East Creek Diversion Channel avoid impacts to the fen. The channel should neither drain this wetland nor cause a decline in water quality.

The Natural Heritage database contains a record for Sessile-flowered Cress (*Rorippa sessiliflora*), a species that is rare in Minnesota. This species occurs on mud flats and sand banks of the Minnesota River. The species was last observed in Carver County (T115, R23) in 1891 and it is unlikely that it will occur at the intersection of the proposed East Creek Diversion Channel and the Minnesota River.

If you have questions regarding our comments, or if you require additional information from the DNR, please contact Wayne Barstad from the Ecological Services Section at 772-7950.

SEP 28 1992
U.S. CORPS OF E...
St. Paul ...

Sincerely,

David Leuthe

David Leuthe
Acting Regional Administrator

c. Thomas Balcom, Planning and Review
John Stine, Waters
Con Christianson, Ecological Services
Bonita Eliason, Natural Heritage
File: Chaskafc.car

MINNESOTA HISTORICAL SOCIETY
FOUNDED IN 1849
Fort Snelling History Center, St. Paul, MN 55111 • (612) 726-1171

May 26, 1992

Mr. Robert J. Whiting
St. Paul District, Corps of Engineers
1421 U. S. Post Office & Custom House
St. Paul, Minnesota 55101-1479

Dear Mr. Whiting:

Re: Phase I Cultural Resources Investigation of the State 3 Channel and the Stage 4 Levee and Ponds, CHaska Flood Control Project, Carver County
MHS Referral File Number: 91-0695

Thank you for the opportunity to review and comment on the above project. It has been reviewed pursuant to the responsibilities given the State Historic Preservation Officer by the National Historic Preservation Act of 1966 and the Procedures of the Advisory Council on Historic Preservation (36CFR800), and to the responsibilities given the Minnesota Historical Society by the Minnesota Historic Sites Act and the Minnesota Field Archaeology Act.

We have reviewed the results of the survey of the borrow area by the Institute for Minnesota Archaeology. Based on the results of this survey, we feel that the probability of any unreported properties being located in the area of potential effect is low. Therefore, we conclude that no properties eligible for or listed on the National Register of Historic Places are within the area of potential effect for the project.

Please contact Dennis Gimmestad at 612-726-1171 if you have any questions on our review of this project.

Sincerely,

Britta L. Bloomberg
Deputy State Historic Preservation Officer

BLB:dmb

cc: Craig Johnson, IMA
Christy Caine

MINNESOTA HISTORICAL SOCIETY
FOUNDED IN 1849
Fort Snelling History Center, St. Paul, MN 55111 • (612) 726-117

December 16, 1991

Mr. Robert J. Whiting
St. Paul District, Corps of Engineers
1421 U. S. Post Office & Custom House
St. Paul, Minnesota 55101-1479

Dear Mr. Whiting:

Re: Phase I Cultural Resources Investigation of the Stage 3 Channel and the Stage 4 Levee and Ponds, Chaska Flood Control Project, Carver County
MHS Referral File Number: 91-0695

Thank you for the information you have submitted on the above referenced project. It has been reviewed pursuant to the responsibilities given the State Historic Preservation Officer by the National Historic Preservation Act of 1966 and the Procedures of the Advisory Council on Historic Preservation (36CFR800), and to the responsibilities given the Minnesota Historical Society by the Minnesota Historic Sites Act and the Minnesota Field Archaeology Act.

Based on the archaeological survey of the area completed by the Institute for Minnesota Archaeology and the other information compiled by your staff, we have concluded that no properties eligible for or listed on the National Register of Historic Places are within the project's area of potential effect.

Please contact me if you have any questions regarding our review.

Sincerely,

Dennis A. Gimmestad
Government Programs and Compliance Officer

DAG:dmb

cc: Craig Johnson, The Institute for Minnesota Archaeology
Christy Caine, State Archaeologist

APPENDIX A

HYDROLOGY

EAST CREEK AT CHASKA, MINNESOTA
STAGE 3, FEATURE DESIGN MEMORANDUM
FLOOD CONTROL PROJECT

APPENDIX A

HYDROLOGY

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PLATES - Continued

EAST CREEK AT CHASKA, MINNESOTA
STAGE 3, FEATURE DESIGN MEMORANDUM
FLOOD CONTROL PROJECT

APPENDIX A

HYDROLOGY

INTRODUCTION

General

1. The Feasibility Report (Reference 1) and the Limited Reevaluation Report (Reference 2) recommended that the East Creek diversion channel inlet be placed just upstream from Engler Boulevard (Plate A-1) at the outlet of subarea EC-9 (Plate A-2). The General Design Memorandum (GDM) (Reference 3) proposed a diversion tunnel and the inlet was moved to the center of subarea EC-10, just upstream from Crosstown Boulevard (Plate A-2). This study (Feature Design Memorandum) is recommending that the diversion channel be used with the inlet placed at the outlet to subarea EC-9 as proposed in the first two reports.

2. The Existing Condition assumes that the East Creek watershed, upstream of the City of Chaska, is rural with very little urbanization. In addition it is assumed that the existing culvert (8 ft. x 8 ft. box) and embankment at the Highway 41 crossing (Plate A-2) are in place. The Future Condition uses the same assumptions at Highway 41 with an urbanized watershed.

3. The Project Condition is defined as the Future Condition (urbanized watershed) with the single culvert under the Highway 41 embankment replaced with a structure with more flow capacity. The replacement of the existing culvert under Highway 41 with a larger capacity structure is a requirement of the Corps' authorized project. The new structure will be designed to prevent the failure of the embankment during a major flood due to overtopping or a head differential created by the storage of flood waters. The failure of Highway 41 during a flood would endanger the Corps' flood control project and the residents of Chaska (Reference 4). Details on the design of the culverts (and a larger embankment) can be found in Appendix J.

4. Two dams have been constructed (in 1989) within the East Creek basin since the GDM was published. In addition, the City of Chaska has plans (Reference 5) to construct a number of storm water detention ponds in the basin at some point in the future. The East Creek diversion channel hydrologic design model, from the GDM, was updated for this study to include the two new dams and three of the detention ponds that already exist.

CLIMATE

General

5. The climate of Chaska and its vicinity is moderate. It is characterized by wide variations in temperature, normally sufficient rainfall for crops, and moderate snowfall. There is a National Weather Service weather observation station within the City of Chaska. It was established in May 1925 and has been in operation since that time.

Temperature

6. The mean annual temperature for Chaska is about 44 degrees Fahrenheit. The mean monthly temperature varies from about 72 degrees in July to 12 degrees in January. The most extreme temperatures recorded were a high of 109 degrees on 4 July 1936 and a low of -43 degrees on 30 January 1951. The average number of days from spring to fall between freezing temperatures is 153.

Annual precipitation

7. The normal annual precipitation at Chaska is 26.0 inches. The normal monthly precipitation varies from a maximum of 4.00 inches in June to a minimum of 0.73 inches in January. Snowfall records for Minneapolis, Minnesota, which is located approximately 19 miles northeast of Chaska, indicate an average annual snowfall of about 44 inches. The snowfall represents approximately 16 percent of the yearly precipitation.

HISTORICAL FLOODS AND RAINFALL EVENTS

East Creek and Chaska Creek

24 - 28 July 1892

8. This storm was centered on Minneapolis, Minnesota (19 miles northwest of Chaska. The storm lasted from 24-28 July 1892 during which a maximum depth of 8.4 inches of rainfall occurred in 60 hours. Of this amount, 6.35 inches fell within 12 hours.

20 - 21 July 1951

9. The largest flash flood at Chaska from Chaska Creek or East Creek overflow, for which detailed information is available,

occurred in the late evening of 20 July 1951. The storm covered portions of southern and central Minnesota with widely varying amounts of rainfall. In the vicinity of Chaska, the rainfall occurred from approximately 8 p.m. on 20 July until 2 a.m. 21 July. Rainfall at the National Weather Bureau gage, 1 mile northeast of Chaska, totaled 3.95 inches. It was reported that an intense downpour at Chaska lasted 1 hour and 45 minutes and that the total rainfall was 4.5 inches. Within 1.5 hours, the creeks spread over two sections of the city causing damage to homes, businesses, and infrastructure. Although not as extensive and devastating as the overflow from the Minnesota River in April 1951, the flood inflicted a sudden scare to residents. The floodwaters vanished almost as quickly as the creeks had risen.

30 - 31 August 1977

10. During the evening of 30-31 August 1977, 4.73 inches of rainfall fell in the vicinity of Chaska. Both Chaska Creek and East Creek left their banks causing relatively minor damage to homes, businesses, and infrastructure.

20 - 21 July 1987

11. A severe storm passed through the Chaska area during the evening of 20-21 July 1987. Chaska and nearby Shakopee, Minnesota reported 7.83 and 9.75 inches of rainfall respectively within a 6 to 8 hour period. At Chaska, the rain started at about 7:15 p.m on 20 July 1987 and ended about 3:00 a.m. on 21 July. The creeks left their banks around 2:00 a.m. on 21 July. Some portions of Chaska reported up to 9 inches of rain. An isohyetal map for the storm was developed from a rainfall survey of the basin. Average rainfall over Chaska Creek and East Creek was 6.13 and 6.68 inches respectively. Very dry antecedent conditions were reported throughout the basin. As a result, discharges were smaller than might have been expected for an event of this magnitude and short duration. The peak discharge on East Creek at Engler Boulevard was later determined to be approximately 800 cfs. The damage due to flooding was relatively minor.

23 - 24 July 1987

12. A second severe storm passed through the area on the evening of 23-24 July 1987. The storm was centered over 9-Mile Creek near Minneapolis, Minnesota (19 miles northwest of Chaska). Edina and Bloomington, Minnesota reported 11.09 and 10.76 inches of rain respectively within a 6 to 8 hour period. At Chaska, the rain started at about 9:30 p.m on 23 July 1987 and ended about 2:30 a.m. on 24 July. The creeks left their banks around 11:45 p.m. on 23 July. Some portions of Chaska reported over 5 inches of rainfall.

An isohyetal map for the storm was developed from a rainfall survey of the basin. Average rainfall over Chaska Creek and East Creek was 3.61 and 4.54 inches respectively. Antecedent conditions were wet due to the 20-21 July storm two days earlier. The peak discharge on East Creek at Engler Boulevard was determined to be approximately 800 cfs (similar to the 20-21 July 1987 event). The damage due to flooding was relatively minor. An attempt to calibrate the HEC-1 rainfall/runoff model (Reference 6) to this event is discussed later in this report.

STREAMFLOW RECORDS

East Creek

13. The United States Geological Survey (U.S.G.S.) has made a few miscellaneous discharge and water quality measurements on East Creek at the U.S. Highway 212 bridge approximately 1 mile upstream from the mouth. The Corps set high water marks and calculated a discharge at Engler Boulevard following the storms the week of 20 July 1987. Table A-1 contains a summary of the available records.

Chaska Creek

14. The U.S.G.S. has also made a few miscellaneous discharge and water quality measurements on Chaska Creek at the U.S. Highway 212 bridge approximately 2 miles upstream from the mouth. The Corps set high water marks along the creek following the storms the week of 20 July 1987. Table A-1 contains a summary of the available records.

TABLE A-1		
Streamflow Records East Creek and Chaska Creek Chaska, Minnesota		
U.S.G.S. Gage No.	Description	Years of Record (1)
4447280-93355201	East Creek at Chaska, MN, Hwy 212 Bridge 1 Mile Upstream From the Mouth	1979-80
NA	East Creek at Chaska, MN, Culvert Under Engler Blvd. 1000 ft. West of Co. Rd. 17, 3000 ft. US From Crosstown Blvd.	1987 Corps Discharge Calc.
05330700	Chaska Creek at Chaska, MN, Hwy 212 Bridge 2 miles Upstream From the Mouth	1967-70 75, 79-80
NA	Chaska Creek at Chaska, MN, Staff gage on the First Street bridge	1987 Corps Stage Data

(1) A number of highwater marks were set by the Corps on Chaska Creek and East Creek following the storms the week of 20 July 1987.

WATERSHED CHARACTERISTICS

General

15. Flows in East Creek are small during most of the year. There is normally some increase in flow in March and April during and immediately after the spring snowmelt. Spring rains often prolong this period of high flow. Intense summer rainstorms can bring a fast rise in discharge. The high flows usually have a short duration, ranging from a few hours to a few days. The lakes and wetlands in the basin help to sustain a continuous flow in the late spring and early summer and provide some natural storage. By late summer, the infiltration capacity is usually high resulting in the need for considerable rainfall to increase the streamflow. The headwaters of East Creek are on top of the steep bluffs that parallel the Minnesota River. The creek descends down a steep, deeply ravined channel to the Minnesota River flood plain and the City of Chaska (Plate A-3).

16. The City of Chaska has a stormwater management plan for the East Creek watershed. The city has recognized the fact that the basin is urbanizing rapidly (Plate A-4). The plan provides for the installation of numerous small storage ponds to control the increased runoff due to urbanization (Reference 5). The ponds are designed to provide a 1 percent exceedance frequency (100-year recurrence interval) level of protection. Natural storage areas exist at many of the sites. Three of the existing ponds were included in this study due to their size and location within the basin.

East Creek

17. The drainage area of the East Creek watershed above the confluence with the Minnesota River is approximately 11.8 square miles. The drainage area of East Creek above the inlet to the diversion channel near Engler Boulevard (outlet of subbasin EC-9) was determined to be 10.1 square miles. Engler Boulevard crosses East Creek just downstream from the diversion channel inlet (Plate A-2). Some portions of the drainage area do not contribute to the peak runoff.

18. East Creek is formed at the outlet of Hazeltine Lake (Plate A-1). The creek flows westward approximately 2,000 feet before entering IDS Reservoir. The outflow from IDS Dam immediately enters North Lake Grace Reservoir. The outflow from North Lake Grace Dam is controlled by the culvert under the Chicago, Minneapolis, St. Paul and Pacific (CMSP) railroad embankment during periods of high flow. The flow then enters the upper portion of Lake Grace Reservoir between Jonathan Boulevard and the CMSP railroad.

19. The outflow from Lake Bavaria flows approximately 3/4 mile east from its outlet through an intermittent channel to Pond EC-P16 (Plate A-1). The outflow from this area enters North Lake Grace Reservoir. After passing through North Lake Grace Dam and the CMSP culvert the flow also enters the upper portion of Lake Grace Reservoir upstream of Jonathon Boulevard.

20. Water in the upper portion of Lake Grace Reservoir must pass through the culvert under Jonathan Boulevard before eventually reaching the Lake Grace Dam outlet works.

21. From Lake Grace Dam, East Creek continues flowing to the south. It is joined by a western tributary in subwatershed EC-8 just upstream of the Minnesota Highway 41 crossing (Plate A-2). Between Lake Grace Dam and Highway 41, East Creek has a channel slope of approximately 28 feet/mile. Downstream of Highway 41, in subwatershed EC-9, the channel becomes more deeply ravined and the channel slope increases to 50 to 60 feet/mile. East Creek leaves the Minnesota River bluffs and enters the Minnesota River

floodplain in the vicinity of the Brandondale Mobile Home Park just upstream of Engler Boulevard. Downstream of Engler, East Creek meanders across the Minnesota River floodplain and into a densely urbanized area of the City of Chaska. East Creek then enters the Minnesota River at river mile 28.1.

22. The hydrologic features of the East Creek watershed are dominated by the presence of three dams (reservoirs), two lakes, and some natural storage (wetlands) areas. All of these features including a majority of the East Creek basin are contained within the corporate limits of the City of Chaska (Plate A-1). A description of the basin's major features, in general downstream order, follows.

Lake Bavaria and Hazeltine Lake

23. There are two natural lakes upstream of the East Creek diversion channel inlet. Both of the lakes (Bavaria and Hazeltine) are in the headwaters of the East Creek basin (Plate A-2). Lake Bavaria is in the northwest corner of the basin and has a water surface elevation of 971 feet (1929 NGVD). Hazeltine Lake is in the northeast corner of the basin and has a water surface elevation of 916 feet (1929 NGVD). The drainage areas of Lake Bavaria and Hazeltine are 1.3 and 0.59 square miles respectively. Elevation-discharge curves were developed for the lake outlets. The drainage areas above the lakes are essentially non-contributing due to the outlet capacities and the ratio of the drainage areas to the storage/surface areas of the lakes.

IDS Dam

24. IDS Dam (Plate A-2) was constructed in 1988-89 and is currently owned by the City of Chaska. The dam is primarily an earth embankment structure containing a free overflow spillway drop structure with a conduit. An emergency spillway (20 ft. wide) has been cut into the land adjoining the right abutment of the dam. The existing dam has: a total width of approximately 150 feet; a height of approximately 15.5 feet; and total storage equalling approximately 450 acre-feet. The total drainage area upstream of the dam is 2.1 square miles. The hydraulic and storage effects of IDS Dam were included in the updated hydrologic design models developed for this study. Pertinent data for IDS Dam is shown in Table A-2.

North Lake Grace Dam

25. North Lake Grace Dam (NLGD) (Plate A-2) was also constructed in 1988-89 and is currently owned by the City of Chaska. The dam is primarily an earth embankment structure containing a free

overflow spillway drop structure with a conduit. An emergency spillway (20 ft. wide) has been cut into the land adjoining the right abutment of the dam. The existing dam has: a total width of approximately 120 feet; a height of approximately 14 feet; and total storage equalling approximately 460 acre-feet. The total drainage area upstream of the dam is 5.8 square miles. The hydraulic and storage effects of NLGD dam were included in the updated hydrologic design models developed for this study. Pertinent data for North Lake Grace Dam is shown in Table A-2.

Storm Water Detention Pond, EC-P16

26. The construction of Pond EC-P16 was a requirement of the Minnesota Department of Natural Resources permit for upgrading Lake Grace Dam (LGD) to the appropriate dam safety standards (see LGD description). Pond P16 is upstream of Lake Grace Dam (Plate A-2). It outlets into North Lake Grace Dam through a culvert under McKnight Road. The road was raised 3 feet to increase storage in the pond and satisfy the permit requirements. The total drainage area upstream of the proposed pond is 3.41 square miles. Pertinent data for Pond EC-P16 is shown in Table A-3. A naturally occurring wetland exists at this location.

Chicago, Milwaukee, St. Paul, and Pacific (CMSP) Railroad Embankment

27. The CMSP railroad crosses East Creek immediately downstream of North Lake Grace Dam (Plate A-2). A 8 x 13 foot concrete box culvert under the CMSP railroad controls inflow into Lake Grace Reservoir during high flows. The backwater effects of Lake Grace Dam extend through and upstream of the culvert. The hydraulic effects of the CMSP culvert were considered in this study. When the water surface on Lake Grace is at the normal pool elevation, the CMSP culvert is approximately half full.

Jonathan Boulevard

28. Jonathan Boulevard crosses Lake Grace Reservoir at approximately the mid-point (Plate A-2). Prior to May of 1992, the culvert connecting the upper and lower pools of Lake Grace, under Jonathan Boulevard, was relatively large (22 foot diameter). As a result, the hydrologic model developed for the General Design Memorandum (Reference 3, Feb. 1984) did not consider the hydraulic effects of this structure. In May of 1992, however, the culvert failed and was subsequently replaced with a 12 x 12 foot culvert. As a result, the hydraulic effects of the Jonathan Boulevard culvert were considered in this study.

Lake Grace Dam

29. Lake Grace Dam (Plate A-2) was constructed in 1968 by the Jonathan Corporation and is currently owned by the City of Chaska. The existing dam is primarily an earth embankment structure containing a free overflow spillway drop structure with a conduit and a stilling basin. An emergency spillway (100 ft. wide) has been cut into the land adjoining the right abutment of the dam. The existing dam has: a total width of approximately 452 feet; a height of approximately 29 feet; and total storage equalling approximately 620 acre-feet. A rehabilitation plan for the dam (see next paragraph) includes raising the top of the dam 1 foot. The drainage area upstream of the dam is 6.5 square miles. Pertinent data for the existing Lake Grace Dam is shown in Table A-2.

30. Lake Grace Dam was inspected for the Corps of Engineers under the authority of the National Dam Safety Program on July 15, 1980. The inspection report (Reference 7) concluded that the dam did not meet accepted dam safety criteria. Since then, the authority for the dam safety program has been passed from the Corps of Engineers to the State of Minnesota, Department of Natural Resources (MNDNR). The MNDNR has approved a plan (References 8, 9, and 14), submitted by the City of Chaska, to bring the dam up to current dam safety standards. Pertinent data for Lake Grace Dam after the proposed upgrade, are shown in Table A-2.

TABLE A-2							
Pertinent Data (1) Lake Grace Dam, North Lake Grace Dam, and IDS Dam, East Creek							
Name of Dam	D.A. Sq.Mi. (2)	Dam Length Ft.	Dam Height Ft.	Elev. Top of Dam Ft.	Normal Pool Elev. Ft.	Emer. Spill. Elev. Ft.	Top of Dam Stor. Ac-ft
Lake Grace Dam Existing	6.5	452	29	905.2	900.0	902.4	620
Lake Grace Dam After Rehab.	6.5	452	30	906.2	899.5	901.9	670
North Lake Grace Dam	5.8	120	14	910.0	902.0	906.0	460
IDS Dam	2.1	150	15.5	920.0	914.0	917.0	450

(1) Elevations are referenced to the 1929 NGVD

(2) Some of the drainage area is non-contributing

Proposed New Highway 212, East Creek Crossing

31. Currently, Minnesota State Highway 212 passes through the City of Chaska. The State of Minnesota, however, plans to construct a new 4-lane freeway (also called Highway 212) north of the city at some point in the future. The freeway will cross East Creek between Lake Grace Dam and the point where Highway 41 crosses the creek (Plate A-1). The State of Minnesota's future plans were investigated to insure that the structure used to span the creek will not alter the hydrologic/hydraulic characteristics of the basin. The proposed freeway will cross the creek at a deeply ravined portion of the valley. The State has indicated that a large bridge will be installed that will not alter the flow characteristics of the stream or restrict flow and create a head differential across the embankment.

Storm Water Detention Ponds EC-P57, and EC-P62

32. There are 2 storm water detention ponds on the main stem of the tributary of East Creek that flows through subareas EC-7, and EC-7AB (Plate A-2). The storage created by these ponds was included in the hydrologic design model. Pertinent data for the ponds is shown in Table A-3. Naturally occurring wetland areas exist at these locations now.

TABLE A-3

Pertinent Data (1)
Storm Water Detention Ponds
East Creek

Name of Retention Pond	Drainage Area Sq. Mi. (2)	Elevation of Top of Berm Ft.	Storage at Top of Berm Ac-Ft
EC-P16	3.41	920	373
EC-P57	1.05	920	99
EC-P62	1.67	883.5	23

(1) Elevations are referenced to the 1929 NGVD.

(2) Some of the drainage area is non-contributing.

Highway No. 41, East Creek

33. Highway 41 also crosses East Creek at a deeply ravined portion of the valley (Plate A-3). It is located approximately 2 miles upstream from the Corps' diversion channel. The existing embankment is 30 feet high and has a 8 x 8 foot concrete box culvert underneath it. During high flows it is likely that the culvert entrance would plug with debris. The resulting head created by the restricted flow could fail the embankment endangering the residents of Chaska and the Corps flood control project. To prevent this, the East Creek flood control project will include the installation of two large culverts under Highway 41. The embankment will also be enlarged at the same time to accommodate an anticipated increase in traffic. Additional details on the design can be found in Appendix J. The slope of the stream bed between Highway 41 and the Corps' diversion channel inlet is

approximately 50 to 60 feet per mile.

HYDROLOGIC MODEL (HEC-1)

General

34. The HEC-1 Flood Hydrograph model (Reference 6) was used to develop the design flood for East Creek (Plate A-2) and update the work that was done in the GDM. In addition to some parameter adjustments, two dams were added and some storm water detention ponds were considered. The two dams were built since the GDM (Reference 3) was published.

35. The hydraulic relationships along the reach between Lake Grace Dam and IDS Dam are complex. The numerous hydraulic structures along this reach result in constantly changing headwater and tailwater relationships during high flow. The HEC-1 models developed for the LRR and GDM (References 2 and 3) were able to model the situation adequately. However, in recent years, the addition of IDS Dam, North Lake Grace Dam, and the new Jonathan Boulevard culvert, has further complicated the situation. As a result, for this study, an unsteady flow model was developed for this reach. The HEC-1 model provided an input hydrograph to the unsteady flow model. Information concerning the unsteady flow model can be found in the next section.

Drainage Areas

36. The drainage area of the East Creek watershed above the confluence with the Minnesota River was determined to be 11.8 square miles. The East Creek watershed was divided into 12 subwatersheds using U.S.G.S. topographic maps with a scale of 1:24000 (10-foot contours). Field trips to the study area confirmed watershed boundaries. The subwatersheds are shown on Plate A-2 and are designated EC-1 through EC-11. The subwatersheds vary in size from 0.25 to 2.11 square miles (Table A-4). Some of the drainage area does not contribute to the peak flow.

Standard Project Storm Precipitation

37. The Standard Project Storm (SPS) was computed in accordance with EM-1110-2-1411, "Standard Project Flood Determinations" (Reference 10) and information contained in TD No. 15, "Hydrologic Analysis of Ungaged Watersheds Using HEC-1" (Reference 11). The SPS is a 96-hour duration event. The version of the HEC-1 model used has a limit of 2000 computation intervals. A 5-minute computation interval was used in the model in order to get adequate unit hydrograph definition on the smaller subbasins. As a result,

the complete 96-hour SPS event could not be input. However, the amount of excess precipitation (after losses) during the first 48 and last 24 hours of the SPS was minimal (0.35 and 0.06 inches respectively). As a result, only the most severe 24 hours (day 3) of the 96-hour SPS were modeled. Standard Project Storm policy loss rates of 1.00 inches initial loss and 0.15 inches/hour uniform loss were used. The SPS 24 hour index rainfall for the area was determined to be 10 inches.

Snyder's Unit Hydrograph Parameters

38. Snyder's unit hydrograph parameters were used in the HEC-1 computer model. The model uses Snyder's coefficients (T_p) and (C_p). Various relationships have been developed between basin characteristics and the Snyder coefficients. Plates A-5 and A-6 show examples of some relationships, which were first presented in an earlier District publication (Reference 12). To determine the Snyder's coefficients the following subwatershed characteristics had to be determined: length of watercourse from the outlet to the upstream limits of the drainage area; length from the outlet to the center of gravity of the drainage area along the watercourse; and the slope associated with the length of the watercourse to the upstream limits of the drainage area. Plates A-5 and A-6 were then used to determine the coefficients T_p and C_p. The natural basin curve (Linsey) on Plate A-5 was used to determine existing condition parameters. The average of the urban curves (Eagleson/VanSickle) on Plate A-5 was used to determine the Future/Project condition parameters.

Baseflow

39. The baseflow on the two creeks is not significant.

Loss Rates

40. For the Standard Project Flood, initial and uniform policy loss rates equal to 1.00 inch and 0.15 inch/hour respectively were used.

Historic Event Modeling

41. A historic rainfall/runoff event was analyzed to test the ability of the HEC-1 model to reproduce the hydrologic conditions in the watershed.

42. A severe storm occurred in the Chaska area on 20-21 July 1987 and on 23-24 July 1987 (see Historical Flood section). The antecedent moisture conditions prior to the first storm were dry.

High water marks were recorded for each event. In addition, isohyetal maps were developed for each storm based on a survey of rain gauges in the basin. A East Creek peak discharge of 800 cfs was calculated for the second storm from the high water marks at the box culvert under Engler Boulevard (Plate A-2). The average precipitation over each subbasin for the 23-24 July storm was calculated from the isohyetal map.

43. The precipitation for the 23-24 July storm was then input into a HEC-1 model. The conditions prior to the storm were assumed to approximate the Soil Conservation Service's (SCS) antecedent moisture condition II. The existing condition unit hydrograph parameters and antecedent moisture condition II curve numbers were adopted (Table A-4). The existing condition was assumed to be appropriate for 1987. A lot of development, however, has occurred since then.

44. The resulting model was calibrated to the 800 cfs value at Engler Boulevard near the outlet of subarea EC-9. The sensitivity of the model was tested by adjusting the value of Snyder's parameter C_p and the SCS curve numbers (CN). In the end the existing condition unit hydrograph parameters shown in Table A-4 were adopted. The AMC II curve numbers (Table A-4 and Reference 2, Table 4A-2), however, had to be lowered an average of 9 percent in order to match the 800 cfs value at Engler Boulevard. This was considered reasonable considering the unusually dry conditions that prevailed prior to the first storm and the unknown effect this may have had on the second event 2 days later. The unsteady flow model was not needed for this analysis.

Table A-4

Summary of Watershed Characteristics a

East Creek and Chaska Creek, C

Subarea designation	Watershed area (square miles)	Length of drainage (miles)	Length to centriod (miles)	Representative slope (percent)	Water surface area (percent)	Snyder's Tp (hours)	Snyder's Cp	30-minute unit hydrograph peak (cfs)	Curve nur SCS AM((CN)
	Watershed Characteristics					Existing Conditi			
East Creek									
EC1	1.30	0.95	0.49	1.28	14	0.80	0.58	540	79
EC2 (3)	2.11	2.05	0.91	1.02	2	1.50	0.76	(2)	(4)
EC2A (3)	0.25	0.38	0.19	5.03	20	0.35	0.53	(2)	(4)
EC3	0.63	1.67	0.70	1.02	0	1.22	0.64	210	73
EC4	0.59	1.25	0.70	1.06	0	0.60	0.54	330	80
EC5	0.91	0.61	0.22	2.19	23	0.41	0.50	700	82
EC6	0.70	0.74	0.21	2.18	37	0.30	0.47	650	75
EC7 (3)	1.05	1.74	0.76	0.76	0	1.35	0.74	(2)	(4
EC7AB (3)	0.62	0.87	0.44	0.84	0	0.75	0.58	(2)	(4
EC8 (3)	0.69	1.44	0.64	1.67	0	0.60	0.55	302	73
EC9	1.35	2.02	1.11	2.10	0	0.27	0.46	1336	73
EC10	1.14	1.55	1.09	1.96	10	0.65	0.61	626	75
EC11	0.49	1.27	0.49	0.45	6	0.22	0.44	480	78
TOTAL	11.83								
Chaska Creek									
1	1.43	2.04	1.10	1.29	1	0.35	0.49	1325	77
1A	0.44	1.25	0.57	0.99	0	1.00	0.58	150	82
2	0.97	1.44	0.87	0.57	4	1.45	0.65	269	77
3	2.53	2.92	1.40	0.21	9	2.70	0.73	436	82
3A	0.65	1.10	0.49	0.05	7	1.50	0.61	165	74
4	3.04	2.50	1.17	0.21	5	2.50	0.74	580	76
5	2.76	2.16	1.06	0.26	10	2.10	0.69	580	80
6	1.60	1.25	0.72	0.50	12	1.30	0.63	483	70
7	1.50	2.23	1.14	0.74	13	1.80	0.68	357	80
TOTAL	14.92								

(1) The Future Condition assumes an urbanized watershed with the existing Highway 41 culvert in place (6x8 foot RC] Highway 41 culvert will be replaced with a bridge/culvert that will not plug and cause water to be ponded.

(2) The HEC-1 model used to develop the General Design Memorandum (GDM) frequency curves used a 30-minu The updated SPF HEC-1 models (modified GDM models) developed for this study use a 5-minute computation

(3) Subarea EC2 was split into subareas EC2 and EC2A for the updated SPF models. This was done to account for N Subarea EC7 from the GDM was split to account for storage ponds EC57 and EC62. Some additional area was ad

(4) Policy loss rates (initial and uniform losses) were used in the updated SPF models adopted for this study.

(5) The Future/Project Condition for Subareas EC10 and EC11 were modeled as part of the interior flood control por

(1)

Table A–4

ımmary of Watershed Characteristics and Synthetic Hydrograph Values

East Creek and Chaska Creek, Chaska, Minnesota

	Existing Conditions						Future/Project Cc			
rface area ... :ent)	Snyder's Tp (hours)	Snyder's Cp	30–minute unit hydrograph peak (cfs)	Curve number SCS AMC–II (CN)	Wetness coefficient SCS	Adjusted curve number SCS AMC–III (CN)	Snyder's Tp (hours)	Snyder's Cp	30–minute unit hydrograph peak (cfs)	Curve numt SCS AMC– (CN)
4	0.80	0.58	540	79	1.15	90.9	0.40	0.50	995	80
2	1.50	0.76	(2)	(4)	(4)	(4)	0.35	0.52	(2)	(4)
0	0.35	0.53	(2)	(4)	(4)	(4)	0.053	0.30	(2)	(4)
0	1.22	0.64	210	73	1.19	86.9	0.35	0.49	490	78
0	0.60	0.54	330	80	1.14	91.2	0.30	0.47	525	86
3	0.41	0.50	700	82	1.13	92.7	0.25	0.41	729	86
7	0.30	0.47	650	75	1.17	87.8	0.15	0.41	779	79
0	1.35	0.74	(2)	(4)	(4)	(4)	0.30	0.39	(2)	(4)
0	0.75	0.58	(2)	(4)	(4)	(4)	0.15	0.42	(2)	(4)
0	0.60	0.55	302	73	1.19	86.9	0.25	0.41	455	76
0	0.27	0.46	1336	73	1.19	86.9	0.22	0.44	1405	77
0	0.65	0.61	626	75	1.18	88.5	(5)			
6	0.22	0.44	480	78	1.15	89.7	(5)			
1	0.35	0.49	1325	77	1.16	89.3	0.18	0.45	1765	80
0	1.00	0.58	150	82	1.13	92.3	0.19	0.43	490	83
4	1.45	0.65	269	77	1.16	89.3	0.26	0.45	950	82
9	2.70	0.73	436	82	1.13	92.3	1.16	0.60	793	84
7	1.50	0.61	165	74	1.19	87.7	0.67	0.64	400	79
5	2.50	0.74	580	76	1.17	88.9	2.50	0.74	580	84
0	2.10	0.69	580	80	1.14	91.2	2.10	0.69	580	84
2	1.30	0.63	483	70	1.21	84.7	0.24	0.45	1706	80
3	1.80	0.68	357	80	1.14	91.2	0.78	0.55	670	81

ing Highway 41 culvert in place (6x8 foot RCP). The Project Condition (PC) also assumes an urbanized watershed. Howe
plug and cause water to be ponded.
m (GDM) frequency curves used a 30–minute computation interval. The (GDM) frequency curve models were not modi
:d for this study use a 5–minute computation interval.
SPF models. This was done to account for North Lake Grace dam which was built in 1989. The GDM models used one su
C57 and EC62. Some additional area was added to Subarea EC8.
SPF models adopted for this study.
deled as part of the interior flood control portion of this study.

2

TI

e A–4

ıristics and Synthetic Hydrograph Values

Creek, Chaska, Minnesota

g Conditions			Future/Project Conditions (1)							
Curve number SCS AMC–II (CN)	Wetness coefficient SCS	Adjusted curve number SCS AMC–III (CN)	Snyder's Tp (hours)	Snyder's Cp	30–minute unit hydrograph peak (cfs)	Curve number SCS AMC–II (CN)	Wetness coefficient SCS	Adjusted curve number SCS AMC–III (CN)
79	1.15	90.9	0.40	0.50	995	80	1.14	91.2
(4)	(4)	(4)	0.35	0.52	(2)	(4)	(4)	(4)
(4)	(4)	(4)	0.053	0.30	(2)	(4)	(4)	(4)
73	1.19	86.9	0.35	0.49	490	78	1.15	89.7
80	1.14	91.2	0.30	0.47	525	86	1.10	94.6
82	1.13	92.7	0.25	0.41	729	86	1.10	94.6
75	1.17	87.8	0.15	0.41	779	79	1.15	90.9
(4)	(4)	(4)	0.30	0.39	(2)	(4)	(4)	(4)
(4)	(4)	(4)	0.15	0.42	(2)	(4)	(4)	(4)
73	1.19	86.9	0.25	0.41	455	76	1.17	88.9
73	1.19	86.9	0.22	0.44	1405	77	1.16	89.3
75	1.18	88.5	(5)					
78	1.15	89.7	(5)					
77	1.16	89.3	0.18	0.45	1765	80	1.14	91.2
82	1.13	92.3	0.19	0.43	490	83	1.12	93.1
77	1.16	89.3	0.26	0.45	950	82	1.13	92.6
82	1.13	92.3	1.16	0.60	793	84	1.11	93.2
74	1.19	87.7	0.67	0.64	400	79	1.145	90.5
76	1.17	88.9	2.50	0.74	580	84	1.11	93.2
80	1.14	91.2	2.10	0.69	580	84	1.11	93.2
70	1.21	84.7	0.24	0.45	1706	80	1.14	91.2
80	1.14	91.2	0.78	0.55	670	81	1.13	91.5

oot RCP). The Project Condition (PC) also assumes an urbanized watershed. However, the PC assumes that the

)–minute computation interval. The (GDM) frequency curve models were not modified for this study.
ɔutation interval.
ıt for North Lake Grace dam which was built in 1989. The GDM models used one subarea called EC2.
ı was added to Subarea EC8.

trol portion of this study.

(3)

STANDARD PROJECT FLOOD

Project Condition, East Creek

45. The Standard Project Flood (SPF) was modeled under the Project Condition assumption. The Project Condition assumes the large culverts at Highway 41, (2 - 12 x 12 ft. RCPs) that are discussed in Appendix J, are in place. The Future Condition (urbanized watershed) was assumed to exist in the basin for the Project Condition for the purpose of computing the rainfall-runoff model parameters.

46. The HEC-1 rainfall-runoff computer model was used to develop the Project Condition, Standard Project Flood (SPF) on East Creek. The model used in the 1984 General Design Memorandum (GDM) (Reference 3.) was modified. A new model was developed in order to account for two new dams that were installed by the City of Chaska since the GDM was published in 1984 (see Table A-2). Other changes were also made including using a shorter computation time interval, SPF policy loss rates, updated unit hydrograph parameters, and a modified Standard Project Storm (SPS) rainfall distribution. Changes in flood routing due to the proposed storm water detention ponds were also made. The Future Condition, Snyder's unit hydrograph parameters from Table A-4 were adopted. The East Creek watershed has been annexed into the City of Chaska. The basin is rapidly urbanizing due to its close proximity to the Minneapolis/St. Paul metropolitan area.

47. In order for this project to proceed on schedule, a preliminary diversion channel design discharge (5500 cfs) was developed (see Table A-5). The channel design proceeded under this assumption while the hydrologic design was being finalized. When the hydrologic design was finished, the resulting discharge (6100 cfs) did not differ enough (10 percent) to warrant a change (see Table A-5).

UNSTEADY FLOW MODEL (DAMBRK)

48. The HEC-1 model was not able to model the unsteady flow conditions between Lake Grace Dam and IDS Dam. The unsteady flow capability of the National Weather Service's dam break model (Dambrk) (Reference 13) was used to analyze this reach. A portion of the Dambrk model (Reference 14) that was used by the City of Chaska for the dam safety Study on Lake Grace Dam was used. The volume of the input hydrographs in the cities' model was verified with the HEC-1 model discussed in this appendix. The HEC-1 hydrograph for subareas EC-1 and EC-2 was substituted for the cities results due to differing assumptions regarding land use. Some assumptions had to be made regarding timing between the unsteady flow model and the HEC-1 model. The output from the unsteady flow model at Lake Grace Dam was input into a HEC-1 model

for the area below the dam.

TABLE A-5

Frequency Curves (1), Design Flood (2), and Standard Project Flood (3)
East Creek
Chaska, Minnesota

(4) Location	(5) Condition	Recurrence Interval (Years) Discharge (cfs) 10	25	50	100	(2) Diver. Chann. Design Flood	(3) Stan. Proj. Flood
E. Chaska Creek at Diversion Channel Inlet, (4)	Existing	2050	2550	2930	3350	----	----
E. Chaska Creek at Diversion Channel Inlet, (4)	Future	2380	2930	3380	3820	----	----
E. Chaska Creek at Diversion Channel Inlet, (4)	Project	----	----	----	----	5500	6100

(1) The frequency curves (10, 25, 50, 100-yr.) were not revised for the FDM. The values from the LRR (Reference 2) are listed here.

(2) The diversion channel design flow. See Standard Project Flood description.

(3) The Standard Project Flood was revised as part of this FDM.

(4) The diversion channel is at the outlet to subarea EC-9.

(5) See the introduction for a description of the conditions.

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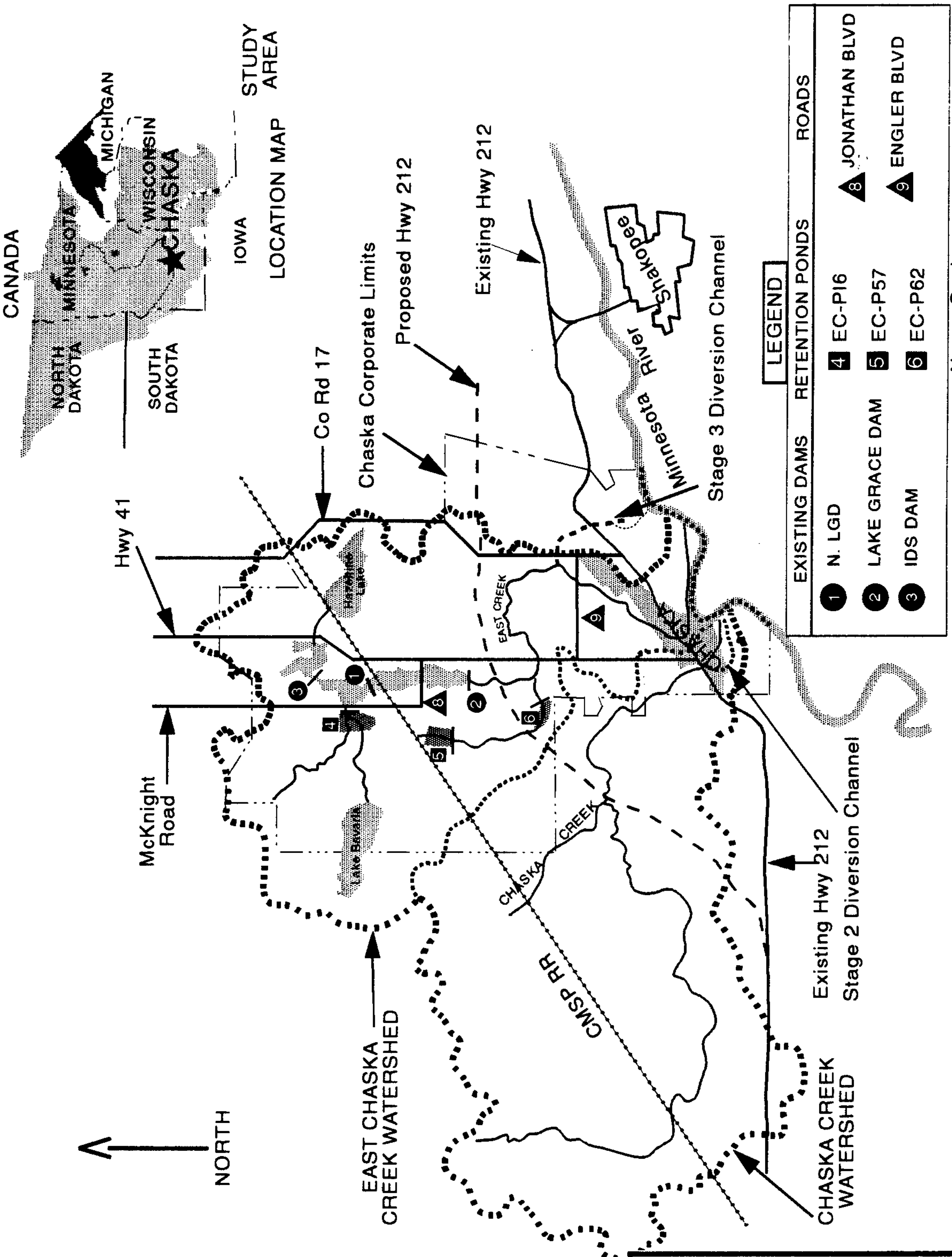
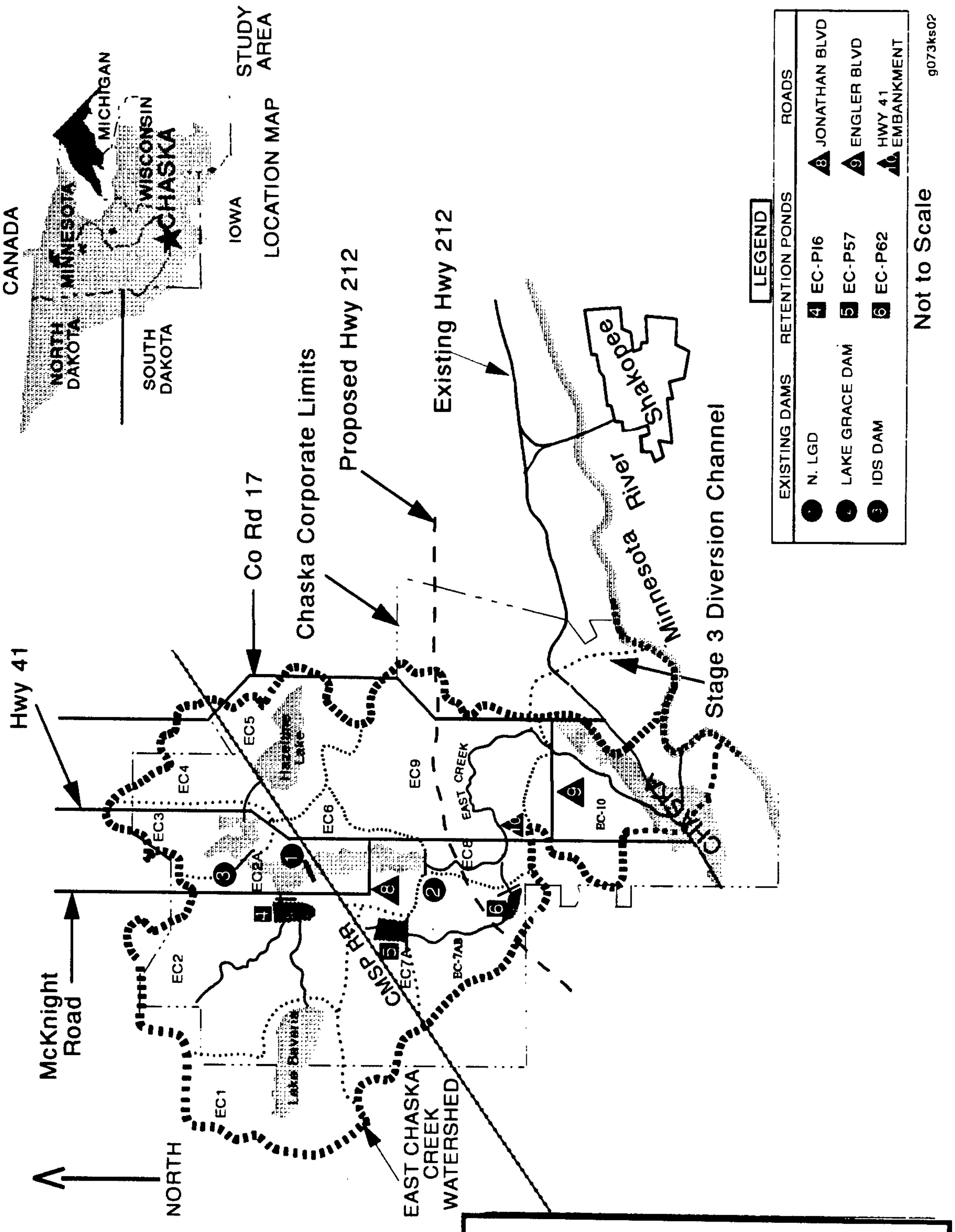


FEATURE DESIGN MEMORANDUM
HYDROLOGIC ANALYSIS
FLOOD CONTROL

EAST CREEK AND CHASKA CREEK WATERSHED CHASKA, MINNESOTA

Location Map

ST. PAUL DISTRICT, CORPS OF ENGINEERS
Plate A-1



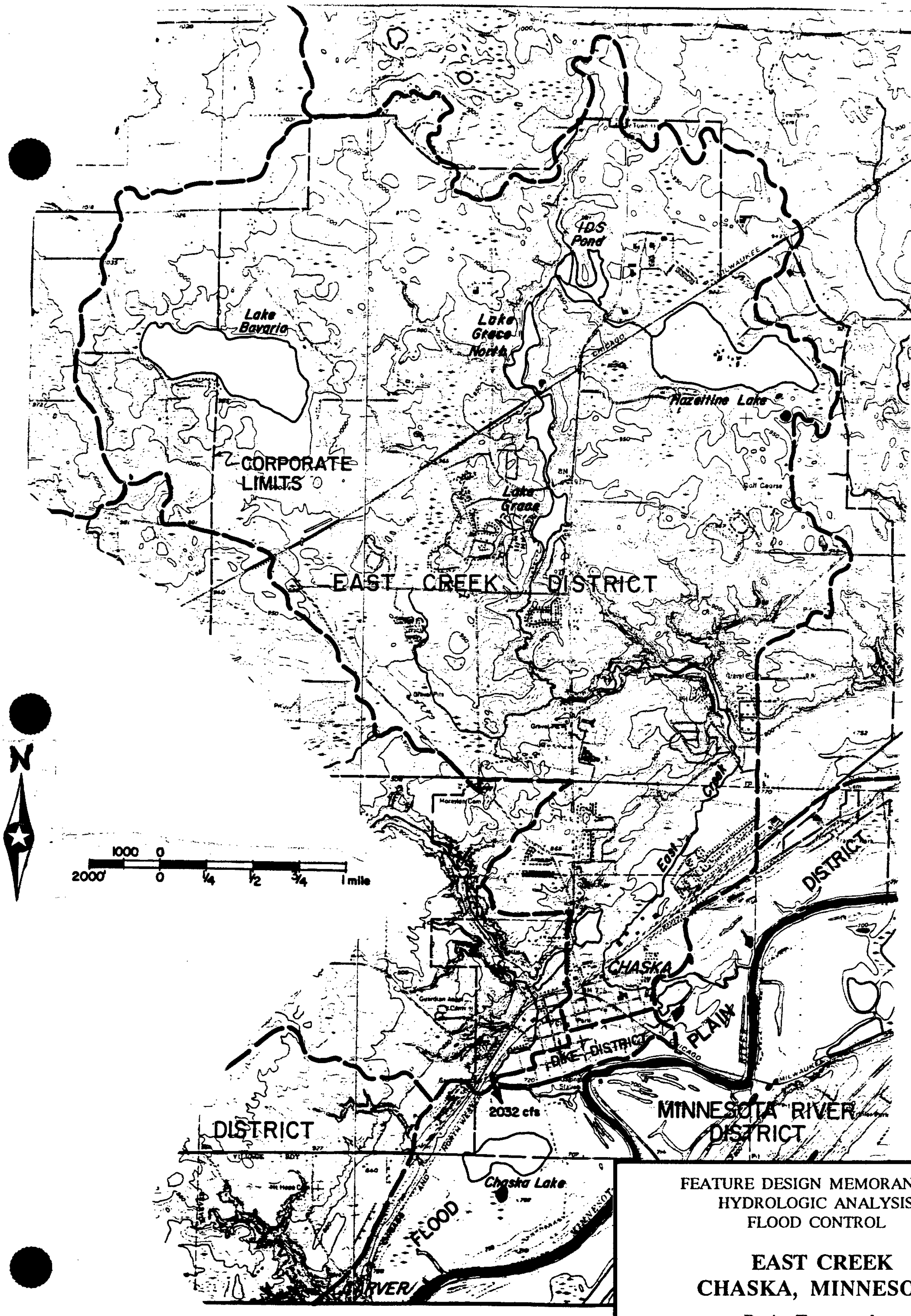
FEATURE DESIGN MEMORANDUM
HYDROLOGIC ANALYSIS
FLOOD CONTROL

EAST CREEK
CHASKA, MINNESOTA

Subbasins

ST. PAUL DISTRICT, CORPS OF ENGINEERS

Plate A-2



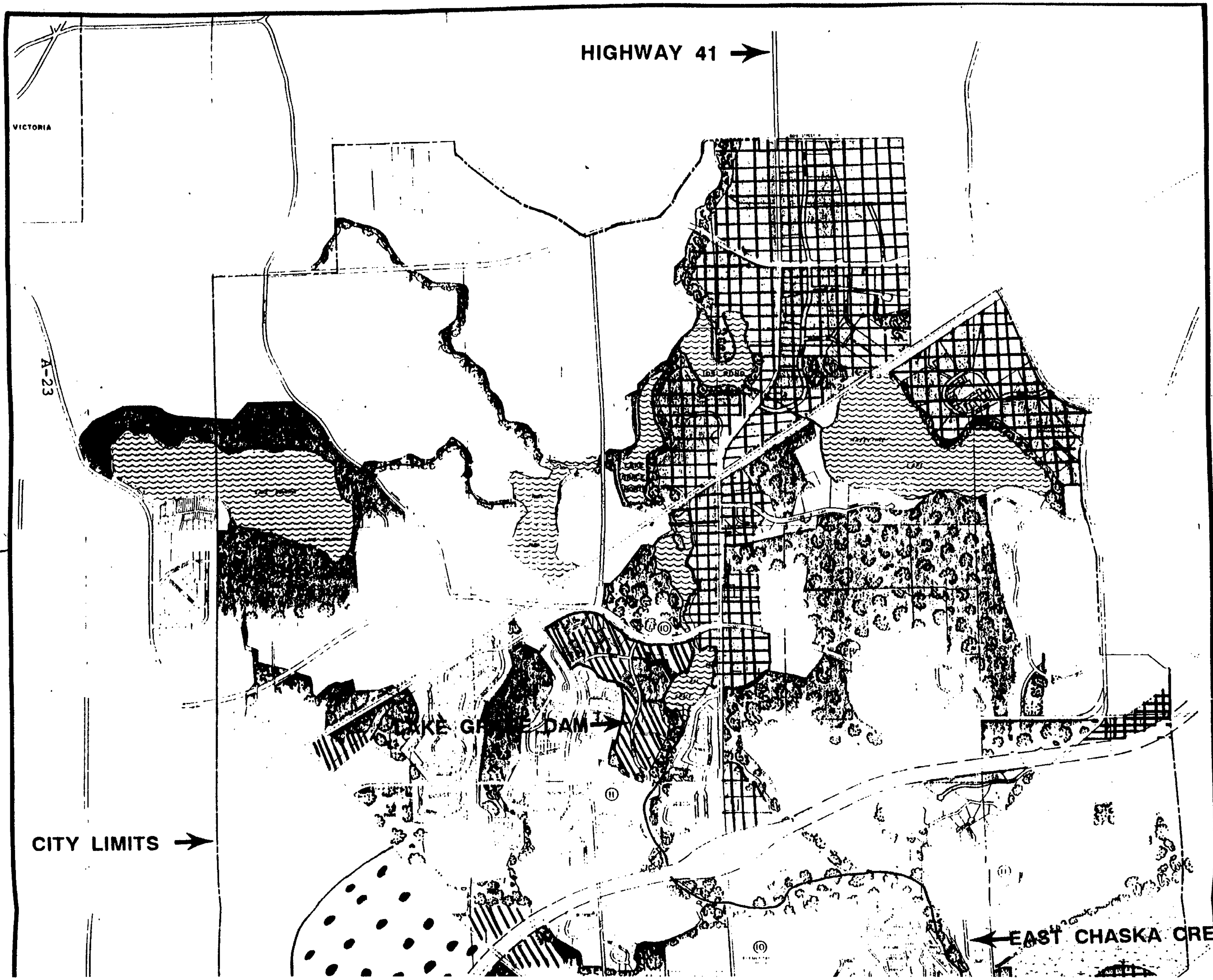
FEATURE DESIGN MEMORANDUM
HYDROLOGIC ANALYSIS
FLOOD CONTROL

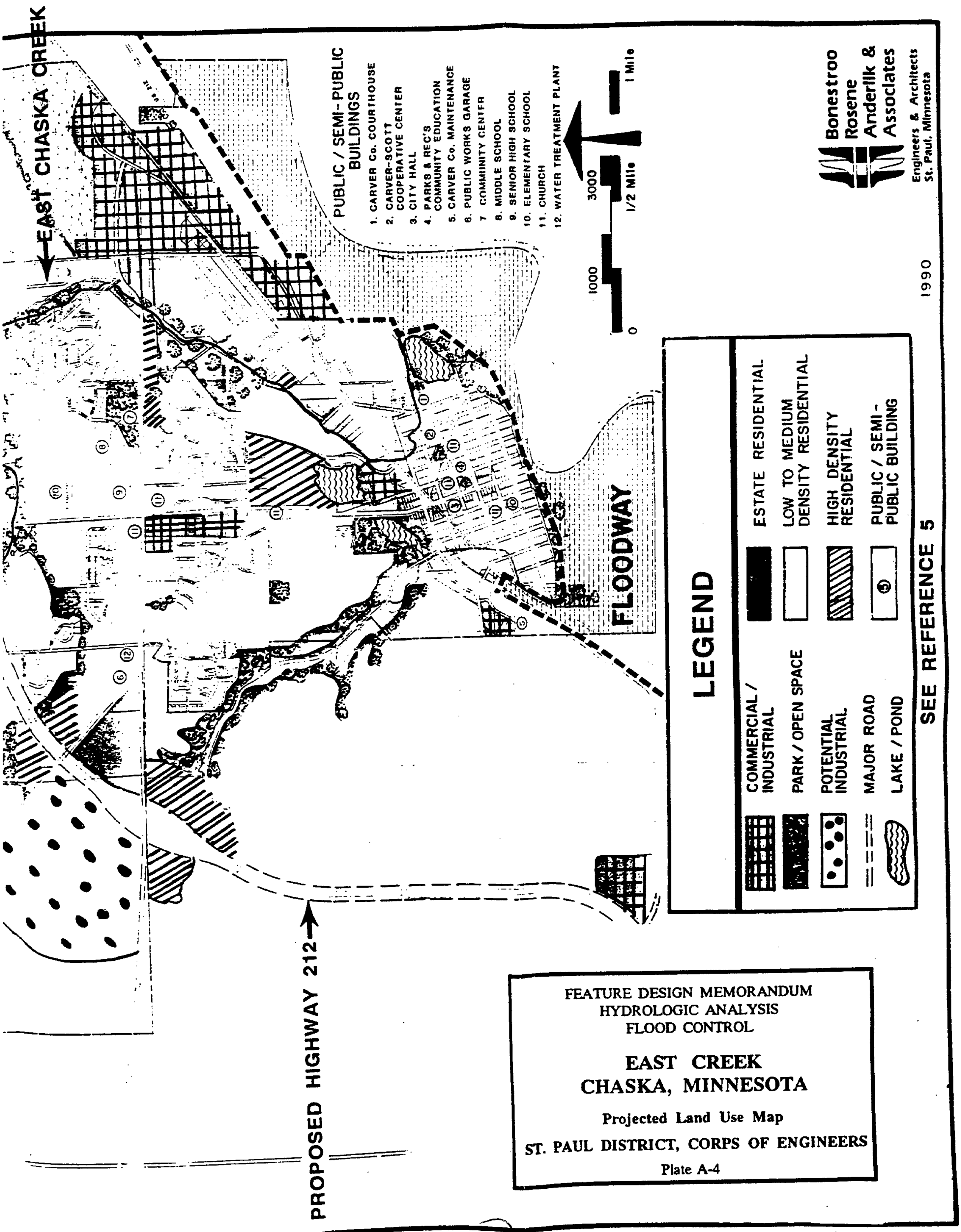
EAST CREEK
CHASKA, MINNESOTA

Basin Topography

ST. PAUL DISTRICT, CORPS OF ENGINEERS

Plate A-3


HIGHWAY 41
VICTORIA
CITY LIMITS
DAM
EAST CHASKA CREEK



FEATURE DESIGN MEMORANDUM
HYDROLOGIC ANALYSIS
FLOOD CONTROL

EAST CREEK
CHASKA, MINNESOTA

Projected Land Use Map

ST. PAUL DISTRICT, CORPS OF ENGINEERS

Plate A-4

(7)

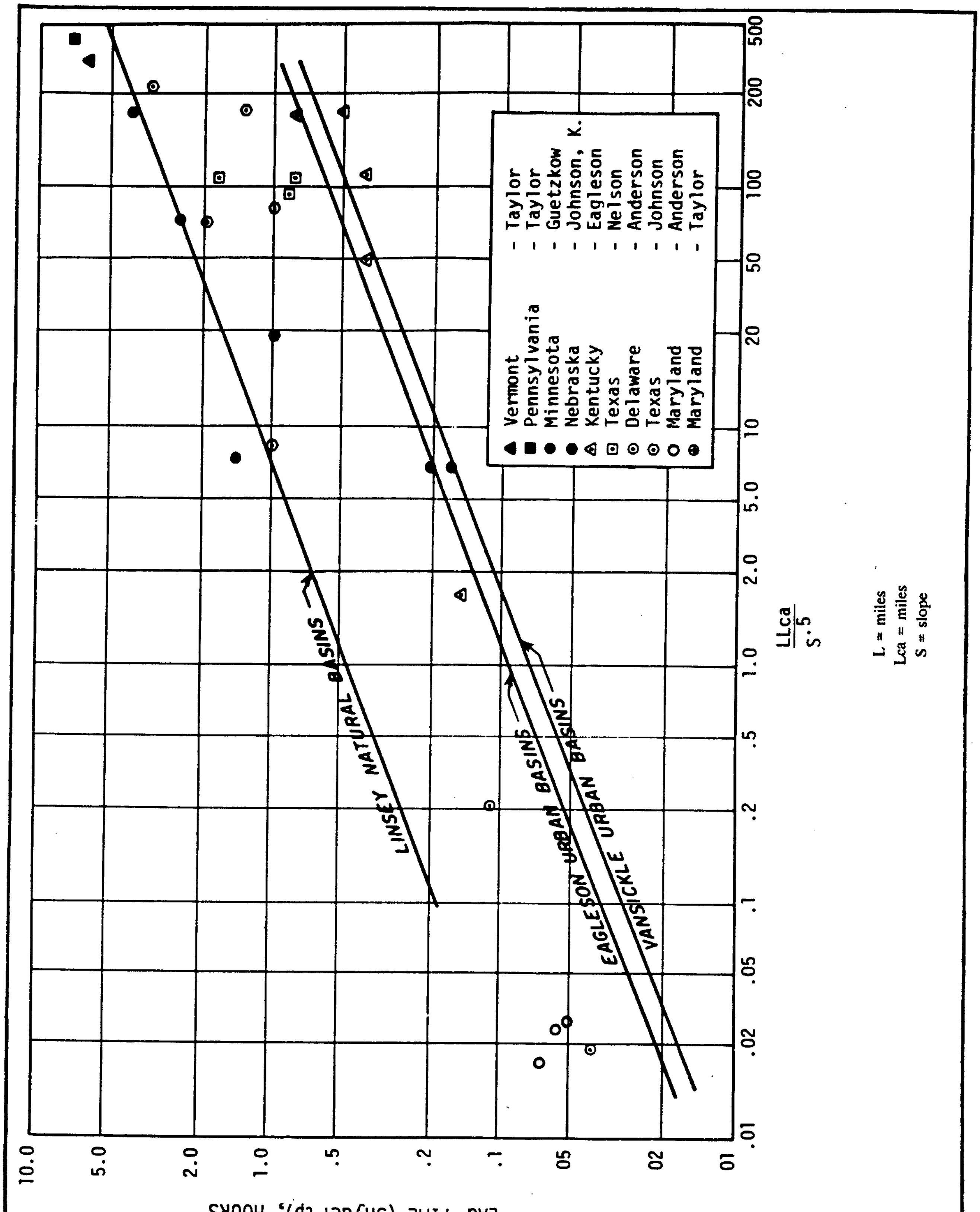


Plate A-5

A - 24

FEATURE DESIGN MEMORANDUM
HYDROLOGIC ANALYSIS
FLOOD CONTROL

EAST CREEK AND CHASKA CREEK WATERSHED CHASKA, MINNESOTA

Basin Lag Versus Basin Characteristics

ST. PAUL DISTRICT, CORPS OF ENGINEERS

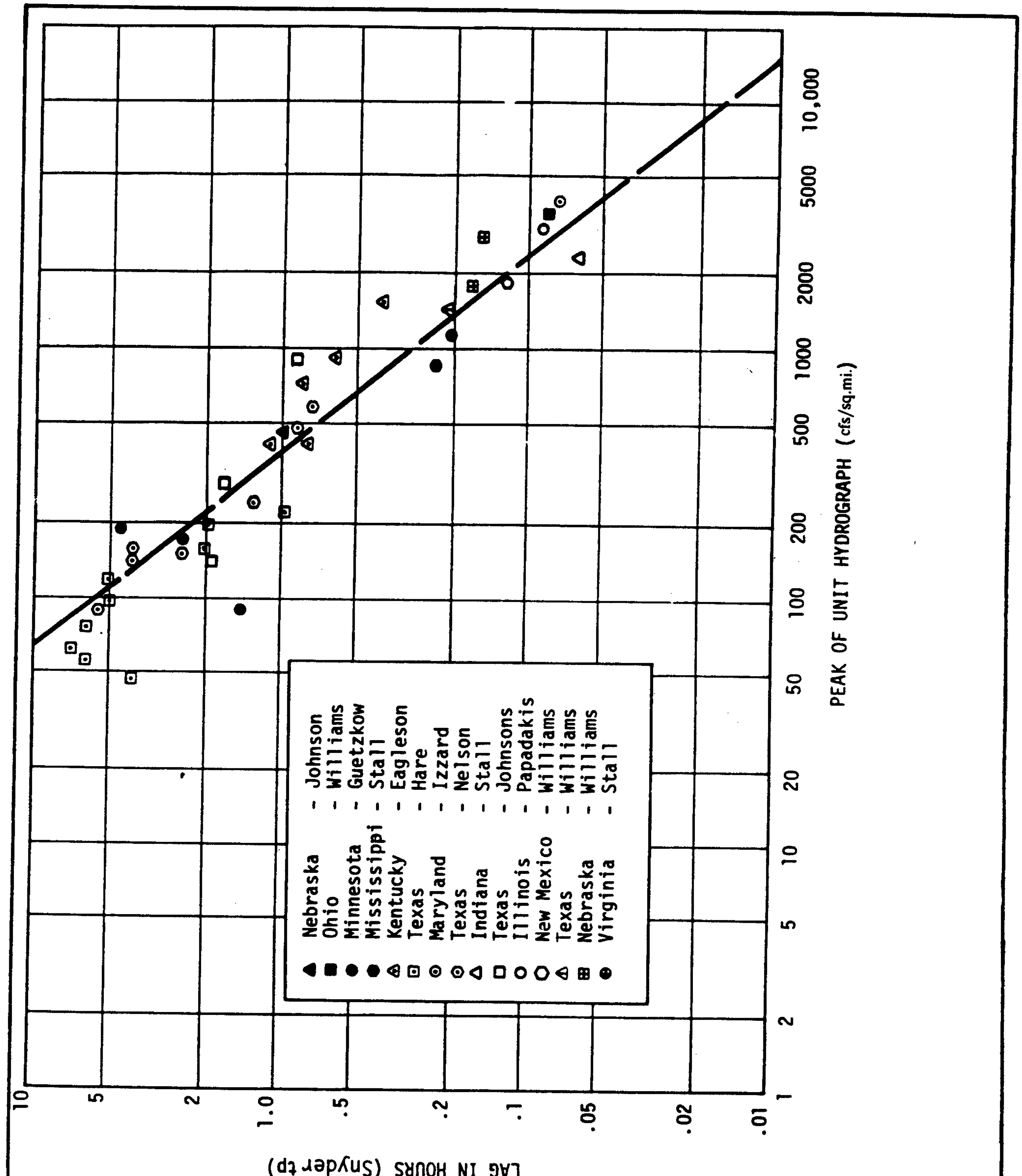


Plate A-6

FEATURE DESIGN MEMORANDUM
HYDROLOGIC ANALYSIS
FLOOD CONTROL

EAST CREEK AND CHASKA CREEK WATERSHED
CHASKA, MINNESOTA

Basin Lag Versus
Unit Hydrograph Peak

ST. PAUL DISTRICT, CORPS OF ENGINEERS

APPENDIX B
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APPENDIX B

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APPENDIX B

HYDRAULIC DESIGN

GENERAL

B-1. This appendix covers the hydraulic design of only those portions of the Chaska flood control project that are included in this feature design memorandum. This includes the East Creek channel diversion. The East Creek channel diversion includes four control structures, an articulated concrete lined supercritical channel from station 0+00 to station 3+75 where the proposed East Creek diversion enters the Minnesota River, a trapezoidal shaped transition section from station 3+75 to station 8+25, a riprapped trapezoidal channel from station 8+25 to station 58+42, and a riprapped overflow diversion structure from station 58+42 to station 58+95. There will be three bridges that cross the proposed diversion channel: Stoughton Avenue at station 16+82, U.S. Highway 212 at station 25+35, and proposed Engler Avenue extension at station 46+25. The design discharge is 5500 c.f.s. at the upstream diversion structure. A discussion of the design discharge is included in Appendix A, Hydrology.

DESCRIPTION OF THE PROJECT

B-2. <u>Outlet Structure.</u> The outlet structure consists of an articulated concrete lined supercritical flow channel with a channel slope of 10 horizontal to 1 vertical. The width of the channel is 250 feet from station 0+00 to 2+85. The invert of the channel is elevation 682.9 at the Minnesota River, station 0+00, and 719.0 at the crest, station 3+50. A profile view is shown on Plate 3 and a typical section view is shown on Plate 12 of the main report. The crest elevation of 719.0 is five feet above the invert elevation of the approach channel. The width of the channel at the crest is 280 feet. This serves as an overflow structure which allows for a high enough tail water in the approach channel, which reduces the velocities and the stilling basin depth for the drop structure located at station 8+25. This was an important consideration in the design of the portion of the diversion channel downstream of Stoughton Ave. because of the existence of a fen in the immediate area. A fen is a type of wetland supported by groundwater discharge, i.e., springs and seepage. A low stilling basin could impact the ground water levels and thus the fen.

Pertinent design information for the articulated concrete lined channel is shown in Table B-1.

Table B-1. Design Data for Articulated Concrete Channel

Manning's "n"	Channel Slope	Normal Depth	Velocity	Froude No.
0.025	0.10	1.3	17.0	2.63
0.035	0.10	1.5	15.0	2.16

B-3. An articulated concrete lined channel is proposed from station 0+00 to station 3+75. The design was based on model studies and design guide by Dr. J.A. McCorquodale, Professor of Engineering, Department of Civil and Environmental Engineering, University of Windsor, Windsor, Ontario. A range of Manning's "n" values of 0.025 to 0.035 was considered. A concrete block with a base of 15" by 15", a top of 12" by 12" and a depth of 8.5" connected together by cable to comprise a mat would meet the criteria in Table B-1. The resulting mat would have a weight of 70 pounds per square foot. With a channel slope of 10-percent, the maximum permissible velocity would be 23.3 ft/sec assuming good placement with good anchoring and good, well compacted and drained subgrade. A geotextile filter cloth would provide a beneficial effect to the stability of the granular subgrade material which in turn would further stabilize the mats. Care should be exercised in the preparation and placement of the mats to minimize unevenness during construction and future settlement.

B-4. Two 24 inch RCP's with a length of 90 feet are proposed through the overflow structure to allow low flows from ground water and local runoff to enter the articulated concrete lined supercritical flow channel without having these low flows flowing over the crest. A low flow channel is proposed from station 0+00 to station 2+85, the outlet of the proposed 24 inch RCP's.

B-5. To determine the depth of the articulated concrete mat below the bottom of the Minnesota River, the equation d2/d1=0.5[((1+8(F1)*2)*0.5)-1] was used. The Froude No., F1, was determined using the equation F1=V1/(gd1)*0.5. The depth, d1, and velocity, V1, were determined using the WASURO computer program developed by the U.S. Army Corps of Engineers, Los Angeles District. This resulted in a depth, d1, of 1.5 feet and a velocity, v1 of 15 fps. Since, over time, there may be an unevenness in the concrete mat, a 0.5 foot change in elevation was assumed to determine the difference in depth, d2, required. It is difficult to determine the level of the Minnesota River during the occurrence of the design flood on East Creek. Low pool on the Minnesota River at the East Creek outlet is 688.0. Pertinent results are shown in Table B-2.

Table B-2. Summary of Required Depth of Protection at Outlet

	With No Unevenness	With a 0.5 Foot Variation
Unit Discharge, q	22 cfs	22 cfs
Approach Depth, d1	1.5 ft	1.0 ft
Approach Velocity, v1	15 fps	22 fps
Conjugate Depth, d2	4.0 ft	5 ft

Using a 0.5 foot variation in the concrete mat, a depth, d2, of 5.0 feet is required. Since an ultra conservative tail water of 688.0 was used, no additional depth is recommended.

B-6. Other alternatives were considered for the reach from Stoughton Ave. to the Minnesota River. One alternative considered a rectangular concrete supercritical flow channel from Stoughton Ave which would flow into a parabolic drop into a Saint Anthony Falls type stilling basin. This alternative was not acceptable because of the required depth of the stilling basin. Affects on the fen as well as stability problems were evident. Widening the stilling basin to lower the unit discharge enough to raise the stilling basin floor to minimize the impact on the fen and eliminate the stability problems was not recommended because of the cost associated with this alternative.

B-7. Another alternative considered a subcritical channel from Stoughton Ave. with a drop structure at the confluence with the Minnesota River. The same problems existed with this alternative as with the supercritical channel from Stoughton Ave. alternative. The selected plan is the least costly alternative.

B-8. Transition Section. A trapezoidal shaped transition section is proposed from station 3+75 at the overflow section to station 8+25 which is at the sill of drop structure No. 1. The bottom width expands from 40 feet at station 8+25 to 250 feet at station 3+75. Flows from ground water and local runoff would be conveyed to the two 24-inch RCP's and into the articulated concrete lined supercritical flow channel. Typical sections of the transition reach are shown on Plate 14 of the main report. Additional information is contained in following paragraphs.

B-9. Channel. The proposed East Creek diversion above the articulated concrete lined supercritical channel consists of four drop structures connected by trapezoidal channels. Channel reach 1 is the supercritical reach discussed in paragraphs 2 through 6. The flow above channel reach 1 is subcritical. Channel reach 2 extends from station 3+75 to the end sill of drop structure 1 at station 8+25. Channel reach 3 extends from the crest of drop structure 1 at station 8+62 to the end sill of drop structure 2 at station 14+62. Channel reach 4 extends from the crest of drop structure 2 at station 15+18 to the end sill of drop structure 3 at station 32+54. Channel reach 5 extends from the crest of drop structure 3 at station 33+00 to the end sill of drop structure 4 at station 51+40. Channel reach 6 extends from the crest of drop structure 4 at station 51+88 to the downstream side of the diversion structure at station 58+52. Pertinent information for the subcritical channel reaches are shown in Table B-3.

Table B-3. Pertinent Channel Information

Reach	Stationing From	Stationing To	Bottom Width	Side slopes	Invert Elevation D/S	Invert Elevation U/S	Channel slope
2	3+75	8+25	Varies	1:3	714.0	715.0	0.00222
3	8+62	14+62	10	1:3	719.0	720.0	0.00167
4	15+18	32+54	10	1:3	736.0	742.0	0.00346
5	33+00	51+40	25	1:3	752.0	756.8	0.00261
6	51+88	58+52	10	1:3	769.6	771.4	0.00271

B-10. The channel inverts and slopes were established based on bridge crossing elevations, existing buildings, existing ground line, and geotechnical considerations. The most critical areas were the reach from station 3+75 to Stoughton Ave., drop structure 3 near station 33+00, and the proposed Engler Ave. extension at station 46+25. The area downstream of Stoughton Ave. was critical because of affects on the fen. The area near drop structure 3 was a concern because of problems with uplift due to artisan pressure. The city of Chaska has plans to extend Engler Blvd. The channel at the proposed crossing had to be designed to match the proposed low chord elevation of 770.5 at the west end of the bridge. The geotechnical considerations are discussed in Appendix D, Geotechnical Design.

B-11. Design Water Surface Elevations. Design water surface elevations were computed for the subcritical flow reaches using the backwater computer program HEC-2. A model was developed separately for each subcritical reach. The model for channel reach 2 assumes critical depth at the crest of the overflow section into the articulated concrete lined supercritical channel and extends to drop structure 1. The model for channel reach 3 assumes critical depth at the crest of drop structure 1 at station 8+62 and extends to drop structure 2. Channel reach 4 assumes critical depth at the crest of drop structure 2 at station 15+18 and extends to drop structure 3. The model for channel reach 5 assumes critical depth at the crest of drop structure 3 at station 33+00 and extends to drop structure 4. The model for channel reach 6 extends from the crest of drop structure 4 at station 51+88 and extends upstream of the diversion structure. A Mannings "n" value of 0.037 was selected for the riprapped channel which begins at 7+25. Contraction and expansion coefficients of 0.1 and 0.3 respectively were selected. The design discharge used in the design of the East Creek diversion is 5500 cfs as discussed in Appendix A, Hydrology. When the hydrologic design was finished, the Standard Project Flood (SPF) was computed to be 6100 cfs. Table B-4 presents the design water surface elevations at selected cross sections for the design discharge of 5500 cfs and the final SPF of 6100 cfs.

Table B-4. Design Water Surface Elevations

Station	Invert Elevation	Water Surface Elev 5500 cfs	Water Surface Elev 6100 cfs	Comments
3+50	719.0	721.5	721.6	Dc - Crest of Overflow
3+60	719.0	721.9	722.1	Overflow Section
3+75	714.0	722.8	723.0	D/S End of Transition
7+25	714.8	722.8	723.0	100' D/S Drop Structure 1
8+62	719.0	727.4	728.0	Dc - U/S Drop Structure 1
10+60	719.4	731.7	732.5	
11+60	719.5	732.2	733.0	
12+60	719.7	732.7	733.4	
13+60	719.9	733.0	733.6	100' D/S Drop Structure 2
15+18	736.0	746.0	746.8	Dc - U/S Drop Structure 2
15+60	736.1	750.9	752.1	
16+50	736.4	751.1	752.2	D/S Stoughton Ave.
17+50	736.5	751.2	752.3	U/S Stoughton Ave.
19+00	737.2	751.6	752.6	
22+00	738.3	752.2	753.2	
25+10	739.4	753.0	753.9	D/S Hwy 212
25+70	739.6	753.4	754.2	U/S Hwy 212
29+00	740.7	754.3	755.1	
30+00	741.1	754.6	755.3	
31+00	741.4	754.9	755.6	150' D/S Drop Structure 3
33+00	752.0	760.4	761.0	Dc - U/S Drop Structure 3
34+00	752.3	764.5	765.4	
36+00	752.8	764.9	765.8	
38+00	753.3	765.4	766.2	
40+00	753.8	765.9	766.6	
42+00	754.3	766.4	767.1	
44+00	754.9	766.8	767.6	
45+80	755.3	767.3	768.0	D/S Engler Blvd.
46+60	755.5	767.6	768.3	U/S Engler Blvd.
48+00	755.9	768.2	768.8	
50+00	756.4	768.6	769.3	150' D/S Drop Structure 4
51+85	769.6	777.9	778.5	Dc - U/S Drop Structure 4
52+65	769.8	781.6	782.8	
53+85	770.3	782.1	783.0	
55+85	770.7	783.2	784.0	
57+35	771.1	784.2	785.0	
58+52	771.4	784.8	785.5	D/S Diversion Structure
58+80	776.0	784.3	785.0	Crest of Diversion Structure
58+92	772.0	785.4	786.0	U/S Diversion Structure
60+87	773.0	786.0	786.6	

B-12. Levees. Levees are required on both the right and left bank to confine the design flood in the proposed East Creek diversion. Table B-5 lists pertinent levee information. The table indicates the design water surface elevation, the water surface elevation for a 6100 cfs event, the top of levee elevation, and the amount of freeboard. The 6100 cfs event is contained in the freeboard.

Table B-5. Pertinent Levee Information

Station	Elevation				Freeboard
	5500 cfs	6100 cfs	Right Levee	Left Levee	
6+39	722.8	723.0	Not Needed	723.8	1.0'
6+75	722.8	723.0	723.8	723.8	1.0'
8+25	722.8	723.0	723.8	723.8	1.0'
8+62	727.4	728.0	732.2	732.2	See Note 1
10+60	731.7	732.5	732.7	732.7	1.0'
11+60	732.2	733.0	733.2	733.2	1.0'
12+60	732.7	733.4	735.2	735.2	2.5'
13+60	733.0	733.6	735.5	735.5	2.5'
15+18	746.0	746.8	753.4	753.4	See Note 1
16+08	751.0	752.1	753.5	753.5	2.5'
16+09	751.0	752.1	Not Needed	Not Needed	
28+70	754.3	755.0	Not Needed	756.8	2.5'
29+60	754.5	755.4	Not Needed	757.0	2.5
29+61	754.5	755.4	Not Needed	Not Needed	2.5
30+60	754.9	755.6	757.4	Not Needed	2.5'
32+54	755.7	756.4	758.2	Not Needed	2.5'
33+00	760.4	761.0	766.8	766.8	See Note 1
34+00	764.5	765.4	767.0	767.0	2.5'
38+00	765.4	766.2	767.9	767.9	2.5'
44+00	766.8	767.6	769.3	769.3	2.5'
46+60	767.6	768.3	770.1	770.1	2.5'
48+70	768.4	769.0	Not Needed	770.9	2.5'
48+71	768.4	769.0	Not Needed	Not Needed	
51+86	777.9	778.5	783.7	783.7	See Note 1
52+65	781.6	782.8	784.1	784.1	2.5'
55+60	783.2	784.0	785.7	785.7	2.5'
55+61	783.2	784.0	Not Needed	785.7	2.5'
58+52	784.8	785.5	Not Needed	787.3	2.5'
59+55	785.9	786.6	Not Needed	788.4	2.5'

Note 1. Plate B-48 of EM 1110-2-1601 shows a typical approach head wall of 1.5 Dc + freeboard. This was compared to the top of levee approaching the drop structure from upstream assuming a constant slope to the structure which turned out to be higher. The upstream walls were, therefore, set at this elevation.

B-13. A 1.0 foot freeboard was selected from station 6+39 to 11+60. The freeboard would then increase to 2.5 feet at station 12+60. In order to minimize the effects on the fen downstream of Stoughton Ave. it was desirable to minimize the freeboard in this reach. A 1.0 foot freeboard is considered adequate. Downstream of station 6+40, levees are not required because of high ground; thus, freeboard is not an issue. The area from station 6+40 to about station 12+60 is in the present 100-yr floodplain of the Minnesota River. Any flows that would exceed the top of levee in this reach would flow overland to the Minnesota River with minimal impacts. A higher freeboard is required upstream because flows exceeding the top of levee for the East Creek bypass would impact on areas not presently subject to flooding.

B-14. Bridges. There are two existing roads that will cross the East Creek diversion: Stoughton Avenue at station 16+82 and U.S. Highway 212 at station at station 25+35. There will also be a crossing at the proposed Engler Blvd. extension at station 46+25. Pertinent information on the proposed bridges crossing the East Creek diversion are presented in Table B-6.

Table B-6. Pertinent Bridge Information

Bridge	Station	Low Chord	Design Water Surface	Freeboard	No. of Piers
Stoughton Ave.	16+82	760.6	751.2	9.4	2
Hwy. 212	25+35	755.0	753.4	1.6	2
Engler Blvd.	46+25	770.5 \1	767.6	2.9	2

\1 The low chord of 770.5 is at the west end of the bridge. The bridge has a 1.28% slope which makes the low chord at the east end 769.0.

B-15. U.S. Highway 41 crosses East Creek in a deeply ravined portion of the valley approximately 2 miles upstream from the Corps' diversion channel. The existing embankment is 30 feet high and has an 8x8 foot concrete box culvert under it. During high flows it is likely that the culvert entrance could plug with debris. The resulting head created by the restricted flow could cause the embankment to fail endangering the residents of Chaska and the flood control project. To prevent this, the East Creek flood control project will include the installation of two large culverts under Hwy 41. The embankment will also be enlarged at the same time to accommodate an anticipated increase in traffic. A trash barrier is proposed upstream of Hwy. 41 which will eliminate plugging of the proposed culverts. The majority of debris in the

basin is above Hwy. 41; thus, no additional debris barriers are proposed for the project. Additional details on the design of the Hwy. 41 crossing can be found in appendix J.

B-16. Curves. For design purposes a ratio of radius to width of 3.0 is suggested in EM1110-2-1601. Pertinent information is presented in Table B-7. The actual radius of curvature for each curve is reasonably close to the minimum required radius. The equation

$$y=(CV^2W)/(gr) \text{ where:}$$

y = rise in water surface between a theoretical level water surface at the center line and outside water-surface elevation (superelevation)

C = coefficient

V = mean channel velocity

W = channel width at elevation of center-line water surface

g = acceleration of gravity

r = radius of channel center-line curvature

Table 2-4 of EM 1110-2-1601 recommends a coefficient C of 0.5 for a trapezoidal cross section. Use of the coefficient allows computation of the total rise in water surface due to superelevation and standing waves. If the total rise in water surface is less than 0.5 ft., the normally determined channel freeboard is considered adequate.

Table B-7. Curve Data

Approx. Station	Top Width (ft)	Average Velocity (fps)	Minimum Radius (ft)	Actual Radius (ft)	Superelev. (ft)
19+00	95	7.2	285	280	0.3
44+00	96	7.5	288	470	0.2
53+30	78	9.3	234	230	0.5

B-17. <u>Erosion Control Structures.</u> There are four drop structures proposed for the East Creek diversion designed to reduce channel slopes to effect nonscouring velocities. The drop structures are CIT- type and were designed using design curves in Plate 48 of EM1110-2-1601. Plate 48 is included in this appendix as Plate B-1. Pertinent hydraulic design data is presented in Table B-8.

Table B-8. Drop Structures - Hydraulic Design Data

	Drop Structure			
	1	2	3	4
Channel Station (at Weir)	8+62	15+18	33+00	51+86
Design Discharge (cfs)	5500	5500	5500	5500
Weir Length (ft)	40	30	40	40
Weir Crest Elevation	719.0	736.0	752.0	769.6
End Sill Elevation	715.0	720.0	742.0	756.8
Yc = Critical Depth (ft)	8.37	10.14	8.37	8.37
Head on Weir (1.5Yc)	12.6	15.2	12.6	12.6
Tailwater Elevation	722.8	733.2	755.7	769.2
Height of Drop, h (ft)	5.0	16.0	10.0	12.8
h/Yc	0.6	1.58	1.19	1.53
h'/Yc (From Design Chart)	0.23	0.37	0.31	0.35
Required Depth of Basin (h')	1.9	3.75	2.60	2.90
Selected Depth of Basin (h')	2.0	3.80	2.60	2.90
Elevation of Basin Floor	712.0	716.2	739.4	754.0
length/(h*Yc)**.5	5.8	4.4	5.0	4.6
Required Length of Basin	37	56	46	48
Selected Length of Basin	37	56	46	48
TW/Yc	1.05	1.30	1.64	1.47

B-18. Riprap Design. Scour protection for the East Creek channel diversion were designed using the following references:

Table B-9. Scour Protection Design References

Protection for	Design References
Channel	EM 1110-2-1601, July 91 Plates B33-B40 ETL 110-2-120, May 71 Enclosure 1
Bridges	EM 1110-2-1601, July 70 Plate 29 (1) ETL 1110-2-120, May 71 Enclosure 3

Note: (1) Curve between isolated cube and USBR per WES recommendation

B-19. Straight Channel. A velocity profile of the East Creek diversion was obtained using the HEC-2 computer program. The pertinent information for the channel reaches is presented in Table B-10. As shown in the table, the average velocities for channel reach 2 range from 2.7 and 5.0 fps to station 7+25. In this reach 12 inch riprap for the low flow channel only is proposed. The riprap requirements downstream and upstream of the drop structures and at the bridges are discussed in later paragraphs.

Table B10. Riprap Design - Straight Channel

Channel Reach	Stationing From	to	Average Flow Depth (ft)	Average Velocity (fps)	Computed D30 (ft)	Selected D30 (ft)
2	3+75	7+25	9.5	2.7/5.0		.48
3	8+87	13+52	12.5	9.0	.30	.48
4	21+00	24+70	13.7	7.8	.13	.48
4	25+90	31+10	13.5	8.1	.14	.48
5	33+25	41+00	12.1	7.5	.12	.48
5	47+10	50+40	12.2	7.3	.12	.48
6	54+50	57+90	12.5	9.6	.22	.48

B-20. Based on a minimum D30 of 0.48 the riprap gradation was selected from Table 3-1 of EM 1110-2-1601. Geotech selected a riprap gradation similar to that and is shown as the selected gradation with a geotech designation of R6. These gradations are shown in Table B-11.

Table B-11. Riprap Gradation - Straight Channel

	Percent Lighter by Weight (lbs) 100 Max	100 Min	50 Max	50 Min	15 Max	15 Min	Thickness
EM 1110-2-1601	86	35	26	17	13	5	12"
Selected Gradation (R6)	85	40	35	20	20	5	12"

B-21. Channel Bends. Channel bend velocities were examined to determine the riprap requirements for the three bends discussed in paragraph 15. Table B-12 shows the results of the bend analysis.

Table B-12. Riprap Design - Bend Analysis

Stationing From	Stationing to	Bend Radius (ft)	Flow Depth (ft)	Channel Width (ft)	Average Velocity (fps)	Computed D30 (ft)	Selected D30 (ft)
17+20	21+00	280	14.2	95	7.2	.46	.48
42+00	46+00	430	12.0	97	7.5	.36	.48
52+50	54+50	230	11.7	78	9.3	.94	.97

B-22. Additional riprap is not required for the bends from station 17+20 to 21+00 and 42+00 to 46+00; however, a riprap with a minimum D30 of 0.94 for the bend from station 52+50 to 54+50 is required. This results in a D30 from EM 1110-2-1601 of 0.97 and a gradation as shown in Table B-13. Geotech selected a riprap gradation similar to that and is shown in Table B-12 as the selected gradation with a geotech designation of R12.

Table B-13. Riprap Gradations - Bend Station 52+50 to 54+50

	Percent Lighter by Weight (lbs) 100 Max	100 Min	50 Max	50 Min	15 Max	15 Min	Thickness
EM 1110-2-1601	691	276	205	138	102	43	24"
Selected Gradation (R12)	690	280	290	140	150	45	24"

B-23. Bridges. Design parameters and riprap requirements for bridges along the proposed reaches of the East Creek diversion are shown in Table B-14.

Table B-14. Riprap Design - Bridge Analysis

Bridge	Approx. Station	Flow Depth (ft)	Average Velocity (fps)	Froude Number	Min W50 (lbs)
Stoughton Ave.	16+50 to 17+20	14.7	7.2	0.45	58
Highway 212	24+70 to 25+90	13.6	8.2	0.55	130
Engler Blvd.	45+40 to 47+10	11.9	8.1	0.52	125

B-24. From Table 3-1 of EM 1110-2-1601, a minimum W50 of 58 pounds would be required for Stoughton Ave. and a minimum W50 of 138 would be required for Highway 212 and Engler Blvd. It is desireable to minimize the number of gradations used in the project if possible for cost and ease of construction. Since the amount of riprap for Stoughton Ave. is not large in comparison to the total riprap required for the project, the same gradation is recommended for the three bridges. Based on a minimum W50 of 138 pounds, a riprap gradation was selected from Table 3-1 of EM 1110-2-1601. Geotech selected a riprap gradation similar to that and is shown as the selected gradation with a geotech designation of R12. These gradations are shown in Table B-15. Riprap layer thicknesses are increased by 50 percent because of turbulent conditions at the bridges. The riprap extends upstream and downstream of the bridges as shown by stationings in Table B-14.

Table B-15. Riprap Gradation - Bridges

	Percent Lighter by Weight (lbs) 100 Max	100 Min	50 Max	50 Min	15 Max	15 Min	Thickness
EM 1110-2-1601	691	276	205	138	102	43	36"
Selected Gradation (R12)	690	280	290	140	150	45	36"

B-25. Drop Structures. Riprap requirements downstream of the drop structures were determined from Hydraulic Design Chart 712-1 presented as Plate B-29 in EM 1110-2-1601 dated 1 July 1991. The high turbulence curves for stilling basins were used. Pertinent information is shown in Table B-16.

Table B-16. Riprap Design - Downstream of Drop Structure

Drop Structure	Stationing From	Stationing To	Average Velocity	Min W50
1	7+75	8+25	10.6	260
2	14+02	14+62	10.9	300
3	31+60	32+54	10.5	250
4	50+90	51+40	11.2	350

B-26. From Table 3-1 of EM 1110-2-1601, a minimum W50 of 270 pounds with a D100(max) of 30 inches would be required for drop structures 1 and 3, and a minimum W50 of 359 pounds with a D100(max) of 33 inches would be required for drop structures 2 and 4. It is desireable to minimize the number of gradations used in the project for cost and ease of construction. Since the amount of riprap needed downstream of drop structures 1 and 3 is not large in comparison to the total riprap required for the project, the same gradation is recommended for all four drop structures. A riprap gradation was selected from Table 3-1 of EM 1110-2-1601 which meets the minimum W50 requirements. Geotech selected a riprap gradation the same as that and is shown as the selected

gradation with a geotech designation of 33. These gradations are shown in Table B-17. Riprap layer thicknesses are increased by 50 percent because of turbulent conditions downstream of the drop structures.

Table B-17. Riprap Gradations - Downstream of Drop Structures

	Percent Lighter by Weight (lbs)						
	100		50		15		
	Max	Min	Max	Min	Max	Min	Thickness
EM 1110-2-1601	1797	719	532	359	266	112	48"
Selected Gradation (33)	1797	719	532	359	266	112	48"

B-27. Pertinent information for the reaches upstream of the drop structures is shown in Table B-18.

Table B-18. Riprap Design - Upstream of Drop Structures

Drop Structure	Stationing From	to	Average Flow Depth	Average Velocity	Computed D30	Selected D30
1	8+62	8+87	8.4	16.4	.92	.97
2	15+20	15+45	10.5	17.0	.95	.97
3	33+00	33+25	8.4	16.4	.92	.97
4	51+86	52+50	8.4	16.4	.92	.97

B-28. Based on a minimum D30 as shown in Table B-19, a riprap gradation was selected from Table 3-1 of EM 1110-2-1601 with a minimum D30 of 0.97. Geotech selected a riprap gradation similar to that and is shown as the selected gradation with a geotech designation of R12. These gradations are shown in Table B-19.

Table B-19. Riprap Gradation - Upstream of Drop Structures

	Percent Lighter by Weight (lbs)						
	100		50		15		
	Max	Min	Max	Min	Max	Min	Thickness
EM 1110-2-1601	691	276	205	138	102	43	24"
Selected Gradation (R12)	690	280	290	140	150	45	24"

B-29. Diversion Structure. Technical Report No. 2-650, June 1964, titled "Stability of Riprap and Discharge Characteristics, Overflow Embankments, Arkansas River, Arkansas". The Technical Report was based on a hydraulic model investigation by WES. The riprapped overflow diversion structure from station 58+42 to station 58+95 was designed along with a 48-inch RCP upstream of the diversion. The 48-inch RCP, outlet E, will allow low flows to continue to flow through the existing East Creek. The design of outlet E is discussed in detail in Appendix C. A rating curve upstream of the diversion structure at outlet E is shown on Plate B-2. Design information for the overflow structure is shown in Table B-20.

Table B-20. Riprap Design - Diversion Structure

Stationing From	Stationing to	Height of Embankment	Unit Discharge	Average Velocity	Approach Energy Depth	Tailwater Depth
58+42	58+95	4.0 ft	68 cfs/ft	10.6 fps	9.9 ft	8.3 ft

B-30. From Plate 47 of TR 2-650 a riprap gradation with a geotech designation of R33 as shown in Table B-18.

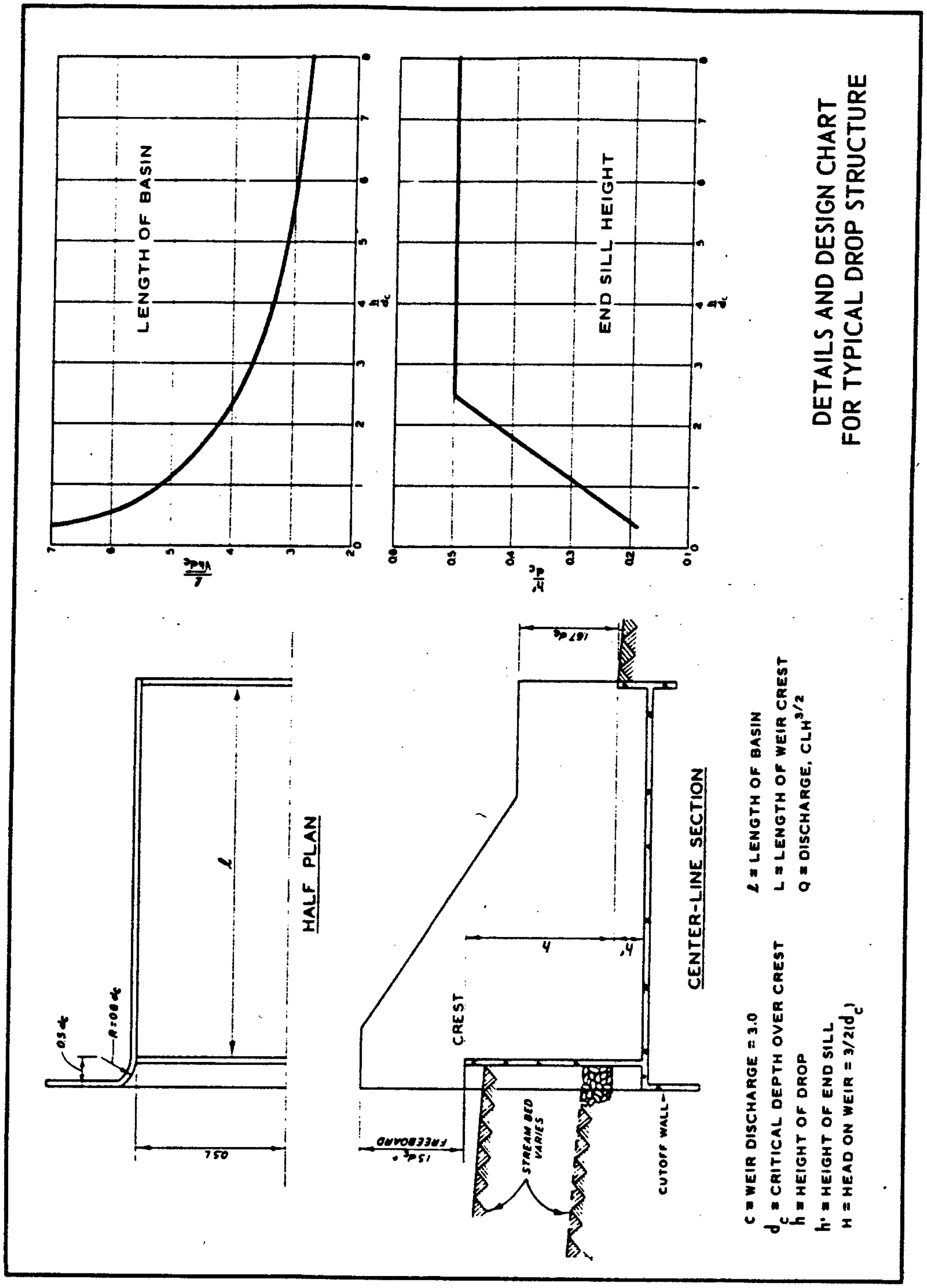
B-31. Riprap Gradations. Table B-21 gives the standard riprap gradations to be used throughout the project. Table B-22 gives the riprap type by station throughout the project.

Table B-21. Summary of Riprap Gradations

Geotech Designation	100 Max	100 Min	50 Max	50 Min	15 Max	15 Min	5 Max	5 Min
R6	85	40	35	20	20	5	15	2
R12	690	280	290	140	150	45	130	25
R33	1797	719	532	359	266	112		

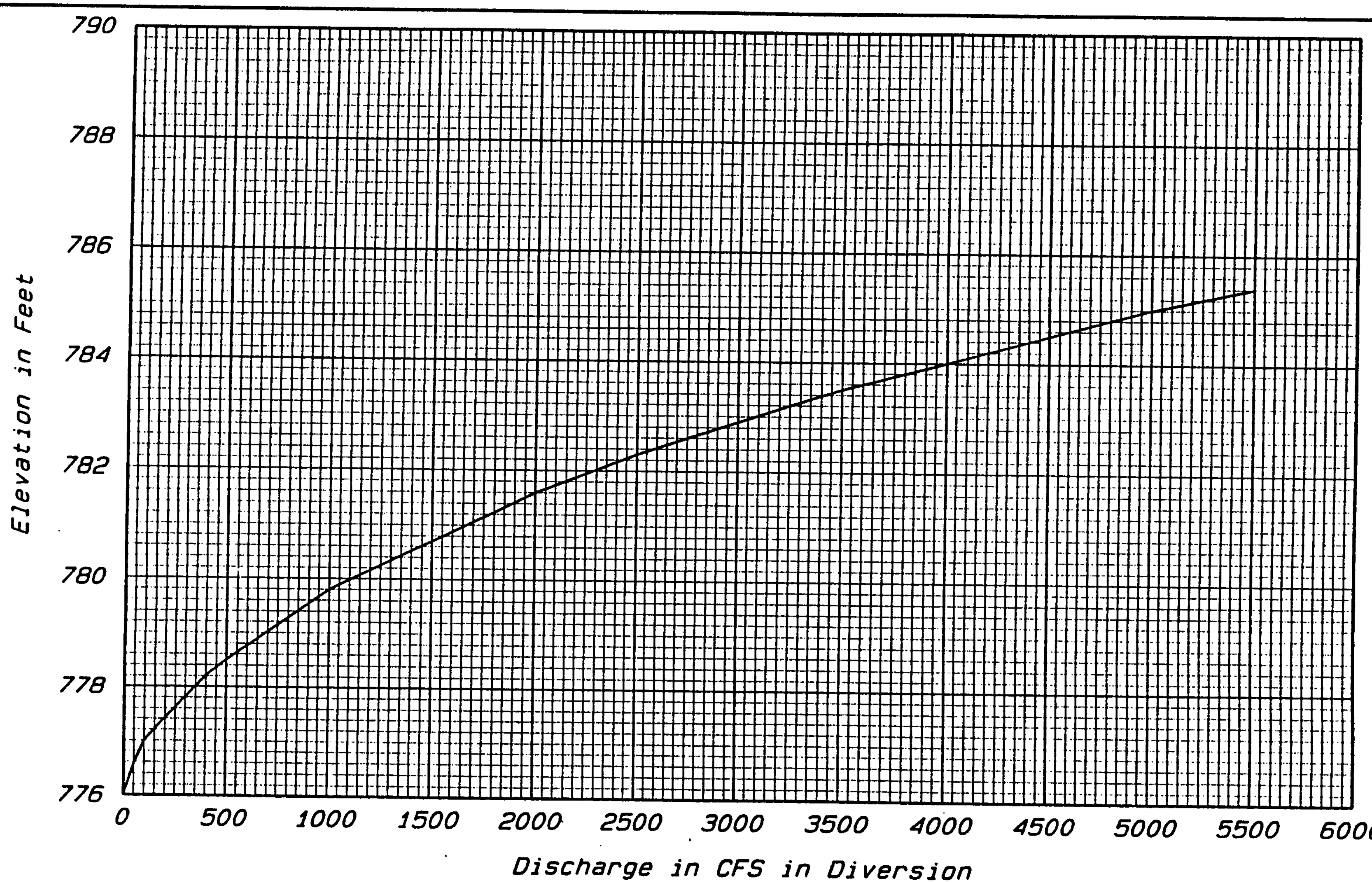
Table B-22. Summary of Riprap by Station

From	to	Length (ft)	Type	Thickness (inch)
3+75	7+25	350	R6	12
7+25	7+75	50	R12	24
7+75	8+25	50	33	48
Drop Structure 1				
8+62	8+87	25	R12	24
8+87	13+52	465	R6	12
13+52	14+02	50	R12	24
14+02	14+62	60	33	48
Drop Structure 2				
15+20	15+45	25	R12	24
15+45	16+50	105	R12	24
16+50	17+20	70	R12	36
17+20	21+00	380	R6	12
21+00	24+70	370	R6	12
24+70	25+90	120	R12	36
25+90	31+10	520	R6	12
31+10	31+60	50	R12	24
31+60	32+54	85	33	48
Drop Structure 3				
33+00	33+25	25	R12	24
33+25	41+00	775	R6	12
41+00	45+40	440	R6	12
45+40	47+10	170	R12	36
47+10	50+40	330	R6	12
50+40	50+90	50	R12	24
50+90	51+40	50	33	48
Drop Structure 4				
51+86	54+50	264	R12	24
54+50	57+90	340	R6	12
57+90	58+42	50	R12	24
58+42	58+92	50	33	48
58+92	59+35	43	R6	12



DETAILS AND DESIGN CHART
FOR TYPICAL DROP STRUCTURE

PLATE B-48



Rating Curve Upstream of
Diversion Structure - Outlet E

APPENDIX C

INTERIOR FLOOD CONTROL

MINNESOTA RIVER AT CHASKA, MINNESOTA
STAGE 3 FEATURE DESIGN MEMORANDUM
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INTERIOR FLOOD CONTROL

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INTERIOR FLOOD CONTROL

EXISTING CONDITIONS

DESCRIPTION OF WATERSHEDS AND DRAINAGE PATTERNS

1. The contributing watershed to the Stage 3 line of protection under proposed conditions includes about 912 acres located along both sides of and contributing runoff to East Creek, from the proposed point of diversion (Proposed Outlet E) downstream to the proposed line of protection (Proposed Outlet D) as shown on Plate C-1.

2. The portion of the East Creek watershed downstream of the proposed Outlet E, excluding the Courthouse Lake area, covers about 894.8 acres. Subsection 4-1, as shown on Plate C-1, consists of about 403 acres located between Outlet E and Crosstown Blvd. Subsection 4-2 includes about 337 acres between Crosstown Boulevard and Highway 212. Subsection 4-3 consists of about 82 acres between Highway 212 and Beach Street/Stoughton Road. Subsection 4-4 includes about 65 acres between Beech Street, Stoughton Road, the proposed line of protection, and the dike (perimeter of subarea "Courthouse Lake Area-Lake") separating Courthouse Lake from East Creek.

3. Except for subareas 4-2B and 4-2C, runoff from Section 4 is by overland flow directly into the East Creek channel. Runoff from areas 4-2B and 4-2C discharges into a depressed area referred to by local interests as the Old Clay Hole. Outflow from the Old Clay Hole is through an existing stormsewer into East Creek. The existing stormsewer connecting the Old Clay Hole with East Creek consists of one 15-inch Rcp, 143 feet long, and three segments of 18-inch Rcp with a total length of about 103 feet. As indicated in Table C-12 (page C-24), the pipe inverts are 726.4(*) at the upstream end of the 15-inch pipe, and about 723.3 at the downstream end of the 18-inch sewer.

4. Elevations in the Section 4 area vary from about 790 at the upstream (north) end to about 706 at the downstream end along the Minnesota River. The Courthouse Lake area is relatively flat ranging from about elevation 725 at the west end to about 705 adjacent to the lake. The estimated size of contributing

(*) All elevations indicated in this appendix refer to National Geodetic Vertical Datum of 1929.

watersheds in acres (Ac) and in square miles (Sm) are indicated on Plate C-1 and in Table C-4 (page C-10).

5. Subsections 4-1 and 4-2 are generally undeveloped, except for some scattered residential development along the hills. Subsections 4-3 and 4-4 contain a mixture of residential and commercial development. The Courthouse Lake watershed contains the Carver County Courthouse and some additional residential development.

6. In watershed 4-4 across the creek from Courthouse Lake (as shown on Plate C-1), there is an existing dike with a top elevation of about 718.1, which protects one farmstead from East Creek flood waters. The farmstead consists of a house, garage, and a barn. The first floor of the house and barn are at elevation 716.0 and 713.0, respectively. There are two outlets with sluice gates located beneath the dike to carry runoff from the farmstead into East Creek: a 24-inch Cmp, about 70 feet long, located near the upstream end of the dike; and a 12-inch Cmp, about 70 feet long, at the downstream end.

7. The watershed area referred to in earlier reports as the Courthouse Lake Area consisted of Courthouse Lake and much of the residential and commercial area located to the southwest to an old railroad embankment, including the Carver County Courthouse and adjacent facilities. At the request of the Lower Minnesota River Watershed District, the City of Chaska now plans to modify their stormwater sewerage system to prevent runoff from this residential and commercial development from entering Courthouse Lake. Subsequently, the city has subdivided the former Courthouse Lake watershed into three sub-watersheds referred to as the Courthouse Lake Area-South, Courthouse Lake Area-North, and the Courthouse Lake Area-Lake; as shown on Plate C-1. Runoff from all three areas will flow overland to the northeast. Runoff from the Courthouse Lake-South area will be intercepted in the Courthouse' south parking lot and carried by a new stormsewer extension in a southwesterly direction to the intercepting stormsewer constructed by the Corps along the Minnesota River during stage 4 construction. Runoff from the Courthouse Lake-North area will be intercepted in the Courthouse' north parking area and diverted by ditch to the north into East Creek just to the west of Courthouse Lake. The remaining Courthouse Lake-Lake area includes the lake and lands immediately adjacent to and which contribute runoff to the lake. A suggested design for the proposed stormsewer extension from the Courthouse Lake-South area to the stage 4 interceptor is described in paragraph 41 (page C-23) and shown on Plate C-2.

8. The Courthouse Lake-Lake area consists of about 12.3 acres of lake surface at elevation 703.0, plus about 4.9 acres of contributing watershed surrounding the lake, or a total of about 17.2 acres. The outlet between Courthouse Lake and East Creek consists of a 18-inch Cmp, about 65 feet long, with a flapgate at

the creek end, and an invert elevation of about 705.6 on the lake side and 706.7 on the creek side. The top of the dike separating the lake from the creek is at about elevation 715.0 or higher. (Unless the level of Courthouse Lake rises above elevation 706.7, there will be no outflow from the Lake into East Creek.)

9. The city of Chaska does not presently have an extensive stormsewer system. All runoff from lands located within the city, with few exceptions, is by overland flow. According to a representative from the city, future stormsewers are to be designed to carry the runoff from about a 20-percent rainfall event, if there are good overflow conditions in the area; and a 10-percent event, if overland flow conditions are relatively poor. The use of supplemental retention basins at interior locations is encouraged and such basins are to be designed to contain the runoff from a 1-percent event.

PONDING AREAS

10. There are currently three temporary ponding areas located within the stage 3 (East Creek) watershed: the Old Clay Hole, Courthouse Lake, and the proposed Outlet D pond (portion of East Creek located adjacent to the Courthouse Lake dike and inside the proposed flood barrier). The location of the Old Clay Hole and Courthouse Lake ponding areas are shown on Plate C-1. The location of the proposed Outlet D pond is shown on Plate C-2. Elevation-area-storage curves for the temporary ponding areas, determined from quad sheets, are presented on Plate C-3.

11. Storage in the Old Clay Hole begins at about elevation 727.0 and, because the area located adjacent to the hole is undeveloped, can satisfactorily store more than 65 acre feet of runoff below about elevation 731.0 without resulting in flood damage.

12. Based on the water surface elevation indicated on the USGS quad sheet, the base level of Courthouse Lake is 703.0, or about 3.7 feet below the lake level where outflow to East Creek will commence. The available storage between elevations 703.0 and 715.0 is about 166 acre feet. The surface area of the lake increases from about 11.7 acres at elevation 703.0 to only about 15.8 acres at elevation 715.0.

13. The capacity of the proposed Outlet D ponding area ranges from zero at elevation 700.0 up to about 84 acre feet at elevation 715.0.

DAMAGE-ELEVATION RELATIONSHIPS

14. Elevation-damage curves developed for the Courthouse Lake area and the temporary ponding area adjacent to Outlet D are presented on Plate C-4. A discharge-damage curve for the East Creek Watershed located upstream of Beech Street is presented on Plate C-5. The

curves presented on Plate C-4 were obtained by updating the curves presented on plates B-9 and B-10 of the revised General Design Memorandum (August 1984) from October 1990 price levels to June 1993 price levels, using the ENR (Engineering News Record) building index. The discharge-damage curve presented on Plate C-5 was obtained from the discharge-damage information presented in Appendix E to same memorandum, updating this information from October 1980 to June 1993 price levels, and plotting the curve presented on Plate C-5. (The ENR Building index for October 1980, October 1990, and June 1993 are 1981.4, 2727.73, and 3066.21, respectively.) The estimated discharge in East Creek upstream of the Highway 212 crossing at commencement of flood damage was determined to be about 900 cfs, based on the discharge rate required to obtain a water surface elevation equal to the top of the adjacent creek bank. Based on the above curves, the zero damage level for the Courthouse Lake area and the area adjacent to Outlet D are about 718.5 and 719.0, respectively. Additional information relative to the development of the damage-elevation-discharge relationships and the location and type of damage which would occur are presented in Appendix E of the revised 1984 Design Memorandum.

STREAM DISCHARGE AND STAGE DATA

Minnesota River

15. Elevation-frequency curves for the Minnesota River at Chaska, obtained from Plate 4-4A of the Limited Reevaluation Report, dated August 1982, are presented on Plate C-6. An elevation-discharge curve for the Minnesota River at the Highway 41 (Chestnut Street) bridge, based on one of a family of curves developed from HEC-2 backwater profiles, is shown on Plate C-7. Based on past HEC-2 studies, a comparison of streamflow levels at the Highway 41 bridge with those at the mouth of East Creek has indicated that the river level at the mouth of East Creek (or proposed Outlet D) will be about 1.0 foot below the level at the Highway 41 bridge. The zero discharge elevation for the Minnesota River at Chaska is 787.2, which corresponds to the flat pool level for the Mississippi River above Lock & Dam No. 2. A stage-duration curve for the Minnesota River at the Highway 41 bridge is presented on Plate C-8. A standard project flood (SPF) hydrograph for the Minnesota River at Chaska is presented on Plate C-9.

16. The United States Geological Survey (USGS) has maintained a stream gaging station on the Minnesota River near either Carver, or Jordan, Minnesota since 1934. The USGS gage was originally located near Carver, Minnesota, (river mile 36.0) but in 1966 was moved to its present location near Jordan, Minnesota, (river mile 39.4) about 9.8 miles upstream from Chaska. The drainage area of the Minnesota River is about 16,200 square miles at the Jordan gage site and about 16,600 square miles at Chaska. Since this is a relatively small increase in drainage area, the discharge-frequency

relations at the Jordan gage were also used for Chaska. At the selected gate closure elevations of 706.0 and 709.0, the discharge in the Minnesota River at the Highway 41 bridge is about 16,000 and 25,400 cfs., respectively, which are equalled or exceeded about 4.0 and 1.5 percent of the time, respectively, or a return period of once in about 25 and 67 years, respectively.

17. The SPF hydrograph for the Minnesota River at Chaska was obtained by increasing the flow rates obtained from the SPF hydrograph for Mankato by the ratio of their respective peak flow rates. The estimated peak SPF flow rate of 168,000 cfs at Chaska was obtained from paragraph 11, page A-3 of the revised GDM for Chaska, dated August 1984. The SPF hydrograph for the Minnesota River at Mankato was obtained from Plate A-20, "Flood Control, Minnesota River, Minnesota, Report On Probable Maximum Floods And Standard Project Floods, Minnesota River Basin, Minnesota," dated January 1971.

East Creek

18. Discharge-frequency information for East Creek is presented in Table A-5, page A-18 of Appendix A. A flood profile for East Creek downstream of the point of diversion, including the one percent; July 21, 1987; and SPF events; is presented on Plate C-10 and in Table C-16 (pages C-27 and C-28). A map indicating the location of bridges over East Creek, and containing an existing flood outline for the one percent and SPF events is presented on Plate C-11.

RAINFALL DATA

19. The 1/4, 1/2, 1-, 2-, 3-, 6-, 12-, 24-, 48-, and 96-hour point rainfall depths for the 40-, 20-, 10-, 4-, 2-, 1-, 0.2-, and 0.1-percent all-year theoretical rainfall events in the Chaska area were developed from National Weather Service (U.S. Weather Bureau) publications HYDRO-35, TP-40, and TP-49 and are presented on Plates C-12 and C-13. A tabulation of the rainfall amounts for durations of 5-, 15-, and 60-minute, and 2-, 3-, 6-, and 12-hours for the above frequency events and the SPS are presented in Table C-1. The point rainfall amounts for the standard project storm, developed in accordance with criteria presented in EM 1110-2-1411, is also presented in Table C-1 and on Plate C-13.

20. Historical rainfall data were obtained from the U. S. Department of Commerce publication "Climatological Data" and from the City of Chaska (for 1993 events only). Recorded daily rainfall records for Chaska are available from August 1911 through August 30, 1993. Since there is no recording gage located in the Chaska area, estimated hourly rainfall amounts have been obtained by use of the hourly amounts from nearby recording gages and proportioning these recorded hourly amounts equal to the recorded daily rainfall amounts at Chaska. The recording gages used are located at either the Minneapolis-St. Paul international airport (located about 22

TABLE C-1

RAINFALL DATA FOR INPUT TO COMPUTER PROGRAM HEC-1

Theoretical Events

Frequency Of Event In Years	Duration: 5-Min	15-Min	60-Min	2-Hour	3-Hour	6-Hour	12-Hour
1000	1.14	2.38	3.95	4.62	5.04	5.75	
SPS	1.05	2.15	3.66	5.10	6.44	9.60	11.15
500	0.95	2.00	3.33	3.90	4.24	4.85	
100	0.85	1.80	3.00	3.53	3.88	4.41	
50	0.77	1.62	2.63	3.16	3.47	4.01	
25	0.69	1.45	2.32	2.79	3.06	3.57	
10	0.59	1.22	2.06	2.47	2.71	3.14	
5	0.48	1.06	1.75	2.09	2.30	2.65	
2.5	0.42	0.92	1.51	1.81	1.98	2.33	

Six Most Intense Historical Events

Date	Hourly Rainfall Amounts: Time In Hours: 1	2	3	4	5	6	7	8	9	10	11	12	13	Total Rainfall (Inches)
July 26-27, 1949	0.08	0.90	1.25	2.49	0.25									4.97
July 21, 1951	0.27	3.14	0.17	0.37										3.95
July 7-8, 1955	0.23	1.31	0.07	0.01	0.24	1.28	0.38	1.71	0.09	0.01				5.33
August 7-8, 1984	0.07	0.29	0.11	1.10	0.11	2.31	0.24	0.00	0.00	0.15	0.33	0.09	0.04	4.84
July 21, 1987	0.27	2.91	0.49	0.31	0.64	1.05	1.61	0.39	0.16					7.83
July 1-2, 1992	0.34	0.11	0.11	2.15	1.02	0.23				0.11			0.11	4.18

miles east- northeast of Chaska), LeSueur, Minnesota (located about 28 miles to the southwest), Northfield, Minnesota (located about 32 miles to the southeast), or at Hutchinson, Minnesota (located about 40 miles to the west-northwest). The hourly rainfall distribution for rainfall events at Chaska with a 48 hour total of 3 inches of more are presented in Table C-2. The six most intense historical rainfall events to occur in the Chaska area occurred July 26-27, 1949; July 21, 1951; July 7-8, 1955; August 7-8, 1984; July 21, 1987; and July 1-2, 1992; and are identified in Tables C-1 and C-2. Table C-3 presents all rainfall events which occurred during or adjacent to periods when the Minnesota River level at Chaska equalled or exceeded elevation 706.0 and had an hourly rainfall of 0.5 inches or more.

RUNOFF HYDROGRAPHS

21. Runoff hydrographs for each of the interior watersheds, located downstream of the point of diversion, were developed based on criteria presented in Soil Conservation Service (SCS) Technical Release 55 (TR55), dated June 1986, titled: "Urban Hydrology for Small Watersheds," and using the HEC-1 computer program. Key parameters used in the computer program are presented in Table C-4. Five-minute unit-hydrographs obtained for each of the East Creek subwatersheds are presented in Table C-5. Runoff hydrographs for the 40-, 20-, 10-, 4-, 2-, 1-, 0.2 and 0.1-percent and standard project theoretical storms and six most intense historical events from the three Courthouse Lake sub-areas are presented in Tables C-6, C-7 and C-8. Runoff hydrographs for East Creek upstream from the proposed point of diversion (Outlet E) for the 10-, 4-, 2-, 1-, and 0.2-percent and standard project storm theoretical events with project conditions, obtained from Plates 4-33A through 4-38A of the Phase I General Design Memorandum, are presented in Table C-9. The East Creek inflow hydrograph for the 0.1-percent event, presented in Table C-9, was obtained by first estimating the peak inflow rate, then assuming the remaining inflow rates for this event are proportional to those obtained for the 0.2-percent event. The estimated peak inflow rate of 5,550 cfs for the 0.1-percent event was obtained by first determining the ratio of the peak inflow rates for the 1-, 2-, and 4-percent events (obtained from Table C-9) to the 6-hour rainfall amounts (obtained from Table C-1), and multiplying the average of these ratios times 5.75, the 6-hour rainfall amount for the 0.1-percent event. Also presented in Table C-9 is the estimated runoff which occurred during the July 1987 historical event. Runoff hydrographs for the 10-, 4-, 2-, 1-, 0.2- and 0.1-percent and standard project theoretical storms and the July 1987 historical event from the remaining interior watersheds (excluding Courthouse Lake) are presented in Table C-10. Runoff hydrographs for the 13 events which occurred during periods of high Minnesota River levels and used in determining the required size of portable pump(s) for Pond D are presented in Table C-11.

TABLE C-2

HISTORICAL RAINFALL EVENTS WITH 48-HOUR ACCUMULATION OF 3.00 INCHES OR MORE
January 1, 1940 Through August 30, 1993

Year	Date	Q	Precip. Total	Loc.	Start Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1944	Jun 4	17800	4.28	M	22	0.80	0.32	0.12																						
1949	Jul 26	840	0.31	M	1	0.10	0.14	0.01																0.76	0.48	0.84	0.96	0.11		0.11
	Jul 27	1070	5.09	M	3	0.01	0.04	0.05	0.01	0.01	0.08	0.90	1.25	2.49	0.25														0.06	
1951	Jul 21	6060	3.95	M	22	0.27	3.14	0.17	0.37																					
1955	Jul 7	1810	3.14	M	19	0.23	1.31	0.07	0.01	0.24	1.28																			
	Jul 8	3510	2.19	M	1	0.38	1.71	0.09	0.01																					
1956	Aug 2	1820	2.80	M	2	0.01						0.01	0.16	0.12	0.50	0.80	0.05	0.02	0.02	0.04	0.02	0.11	0.16	0.12	0.32	0.27	0.06	0.01		
	Aug 3	2600	1.11	M	2	0.18	0.14	0.04	0.23	0.38	0.02																0.06	0.06		
1957	Jun 22	8660	3.26	L	21	0.85	1.30	0.40	0.15	0.16	0.05	0.03	0.08	0.08		0.01	0.04	0.10	0.01											
	Jun 23	11600	0.25	L	19	0.02	0.12	0.05			0.06																			
1959	Jun 25	962	3.15	M	2	0.12							0.02				0.05		0.02	0.49	1.20	0.75	0.43	0.05	0.02					
	Jun 26	1470	0.46	M	4	0.46																								
1960	May 18	4480	0.86	L	10	0.05		0.03	0.15	0.07	0.02	0.09	0.21	0.15	0.07					0.02										
	May 19	5680	0.97	L	3	0.22	0.39	0.19																						
	May 20	7780	2.60	L	1	0.05	0.29	0.09	0.02	0.10	0.24																0.17			
	May 21	12100	2.08	L	1	0.30	0.30	0.07	0.47	0.17	0.10	0.03	0.02	0.02	0.31	0.09	0.02	0.09	0.02	0.03	0.02	0.02	0.34	0.10	0.31	0.64	0.21	0.19	0.02	
1968	Jun 13-14	4680	3.87	M	9	0.09	0.16	0.63									1.43	1.04	0.52											
	Jul 12	1880	1.97	M	4	0.19	1.38	0.20	0.02							0.03								0.02	0.08	0.05				
	Jul 13	2520	1.07	M	1	0.01		0.05	0.17	0.25	0.21	0.07	0.26																	
	Jul 14	4240	1.28	M	1	0.02	0.02					0.89	0.06	0.10	0.01	0.15	0.03												0.05	
1978	Jun 15	3840	0.96	M	15	0.24	0.08		0.24	0.24	0.16																			
	Jun 16	3750	2.26	M	5	0.25										0.08		0.97		0.08		0.80	0.08							
	Jun 17	4030	0.08	M	9	0.08																								
	Aug 26	1070	0.81	M	22	0.03	0.15	0.63																						
	Aug 27	1180	2.70	M	1	0.79	0.80	0.29	0.54	0.19			0.04	0.02	0.01	0.02														
1980	Jun 4	11000	0.07	M	19	0.04					0.03																			
	Jun 5	11900	1.65	M	1	0.06	0.02	0.49	0.90	0.15	0.02	0.01										0.11	0.13	0.25						
	Jun 7	12900	1.18	M	1	0.04	0.85	0.28	0.01																					
1981	Jul 11-12	3920	3.00	L	1	0.29			0.11	1.29	0.50	0.33	0.48																	
	Aug 5-7	5720	3.16	M	4	0.78	0.32	0.16	0.16	0.32														1.26	0.16					
1983	Jun 20	10700	0.30	M	9	0.30																								
	Jun 21-22	12600	2.82	M	9	2.55	0.27																							
1984	Aug 7-8	6960	5.10	M	24	0.07	0.29	0.11	1.10	0.11	2.31	0.24			0.15	0.33	0.09	0.04						0.02	0.11	0.09	0.04			
1987	Jul 21	3100	7.83	M	19	0.27	2.91	0.49	0.31	0.64	1.05	1.61	0.39	0.16																
	Jul 23-24	2490	3.25	M	20	0.75	0.87	0.84	0.16	0.35	0.28																			
1988	Aug 2	2560	0.48	M	9	0.03							0.13	0.22	0.07	0.03														
	Aug 3	2970	1.52	M	3	0.01																								
	Aug 4-5	3560	1.61	M	1	0.04	0.90	0.34	0.15	0.03														0.64	0.01	0.68	0.18			
1992	Jul 1-2	<16000	4.18	L	9	0.34	0.11	0.11	2.15	1.02	0.23				0.11			0.11											0.03	0.12

TABLE C-3

PRECIPITATION RUNOFF DURING PAST EVENTS AT CHASKA, MINNESOTA
WHEN THE MINNESOTA RIVER WAS AT OR ABOVE ELEVATION 706.0
AND ACCUMULATED ONE-HOUR RAINFALL EQUALLED OR EXCEEDED 0.5 INCHES
January 1, 1940 - August 30, 1993

Year	Date	Q	Total Precip. In Inches	Total Runoff In Inches (*)	Loc.	Start Of Runoff (Hour)	Hour: 1	2	3	4	5	6	7	8	9	10	18	19	20	21	22	23	24	25
1944	May 2	14700	1.16	1.81	M	10	0.03	0.83	0.24	0.11	0.06	0.03	0.43	0.08										
	May 3	15800	1.99	0.12	M	10	0.04	0.08																
	Jun 4	17800	4.28	3.15	M	22	0.30	0.27	0.07									0.26	0.43	0.79	0.91	0.06		0.06
	Jun 13	15800	1.11	0.15	M	12	0.15																	
	Jun 23	18000	1.05	0.50	M	19	0.50																	
1953	Jun 13	22900	0.89	0.34	L	1	0.09	0.25																
1957	Jul 3	21700	1.83	1.18	M	6		0.55	0.40	0.23														
1960	Apr 13	18600	1.07	0.21	L	21	0.01	0.20																
1965	May 7-8	16100	2.09	1.96	L	22	0.13	1.20	0.44	0.08	0.11													
1967	Apr 5	16300	1.34	1.24	M	20	0.34	0.26	0.02	0.34	0.26	0.02												
1972	Jun 14	16800	1.17	0.62	M	21	0.62																	
1975	Apr 27	16800	1.54	0.55	M	6	0.11						0.36	0.08										
1979	Aug 29	23200	1.54	0.94	M	14	0.20	0.13	0.61															
1983	Mar 6	27600	1.23	0.22	M	17	0.06	0.11	0.05															
	May 12-13	21700	0.90	0.11	M	16	0.03	0.08																
	Jul 4	17300	1.43	0.88	M	13	0.78	0.10																
1984	Apr 30	17600	1.33	0.18	M	24	0.09		0.04	0.05														
	May 6-7	23600	1.12	0.33	M	24	0.28	0.05																
	Jun 17	18200	0.84	0.16	M	13	0.16																	
	Jul 10-11	17100	2.64	1.88	L	7	0.25	0.13		0.24	0.98	0.28												
1986	Apr 15	31400	1.27	0.32	M	1	0.32																	
	Apr 28	26600	1.63	0.09	M	16	0.09																	
	May 11	23300	1.23	0.01	M	1	0.01																	
	Jun 22	13900	2.52	0.73	M	20	0.09	0.36		0.27	0.01													
1992	Jul 1	<16000	4.18	3.21	L	12	2.06	0.97	0.18															
1993	Jun 16-17	23500	1.94	0.57	M	24	0.14	0.01	0.03	0.04	0.13	0.14	0.08											
	Jul 1	60000	2.75	1.40	M	5	0.05										1.35							
	Jul 3	52000	2.15	1.13	M	12	0.88	0.25																
	Aug 8-9	25000	1.35	0.21	M	2	0.02		0.19															
	Aug 18	23500	1.70	0.67	M	6	0.22	0.41	0.03	0.01														

(*) Runoff determined assuming an infiltration rate of 0.5-inch during first hour and 0.05-inch during each succeeding hour.

TABLE C-4

INTERIOR WATERSHED HYDROLOGICAL CHARACTERISTICS

Section	4-1cd	4-1b	4-1a	4-2c	4-2b	4-2a	4-3	4-4	Courthouse North	Lake Area South	Lake
Area In Acres	176.8	112.6	113.7	165.7	55.7	115.8	82.0	64.6	7.9	9.5	(1)4.9
Area In Square Miles	0.278	0.176	0.178	0.259	0.087	0.181	0.125	0.101	0.012	0.01484	0.00766
Slope In Feet/Feet											
Sheet Flow	0.020	0.040	0.020	0.100	0.130	0.070	0.005	0.070	0.00323	0.01550	0.07500
Shallow Concentrated Flow	0.020	0.025	0.005	0.021	0.100	0.100	0.004	0.011	0.00323	0.00320	-
Channel Flow	0.038	0.055	0.006	-	-	-	-	-	-		
Watershed Length In Feet											
Sheet Flow	300	300	300	300	300	300	300	300	300	200	200
Shallow Concentrated Flow	600	1700	1800	2600	1100	2600	2400	1400	1250	750	-
Channel Flow	4200	2500	1200	-	-	-	-	-	-	-	-
Sheet Flow Surface Description (*)	DG	DG	DG	DG	LU	DG	S	LU	DG	DG	DG
Manning's n	0.24	0.24	0.24	0.24	0.4	0.24	0.011	0.40	0.24	0.24	0.24
Two-Year, 24-Hour Rainfall (P2)	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8
Shallow Concentrated Flow Surface Description (*)	UP	UP	P	UP	UP	UP	P	UP	P/UP	P/UP	-
Average Velocity In Feet/Second	2.3	2.5	1.4	2.2	5.0	5.0	1.4	1.6	1.3	1.3	-
Channel Flow											
Cross Sectional Flow Area In Square Feet	32	32	-	-	-	-	-	-	-	-	-
Wetted Perimeter In Feet	22.6	22.6	-	-	-	-	-	-	-	-	-
Hydraulic Radius In Feet	1.4	1.4	1.4	-	-	-	-	-	-	-	-
Mannings Roughness Coefficient (n)	0.035	0.030	0.030	-	-	-	-	-	-	-	-
Velocity In Feet/Second	10.4	14.6	4.8	-	-	-	-	-	-	-	-
Time Of Concentration In Hours									0.16867	0.31602	0.59375
Sheet Flow	0.61	0.46	0.61	0.32	0.44	0.37	0.09	0.56	1.27	0.49	0.26
Shallow Concentrated Flow	0.07	0.19	0.36	0.33	0.06	0.14	0.48	0.24	0.28	0.16	-
Channel Flow	0.11	0.05	0.07	-	-	** 0.20	-	-	-	-	-
Total	0.79	0.70	1.04	0.65	0.50	0.71	0.57	0.80	1.55	0.65	0.26
Lag Time In Hours	0.47	0.42	0.62	0.39	0.30	0.43	0.34	0.48	0.93	0.39	0.16
SCS Curve Number - Existing Conditions (2)	62	62	75	62	55	88	69	69	83	81	69
- Future Conditions (10% Increase)	68.2	68.2	82.5	68.2	60.5	96.8	75.9	75.9	-	-	-

(*) Surfaces were assumed to be either: dense grass (DG), light underbrush (LU), smooth surface (S), paved (P), or unpaved (UP).

(**) Channel flow in East Creek (HEC-2 code).

(1) Area contributing to lake is 4.9 acres. The area of Courthouse Lake at elevation 703.0 is about 12.3 acres.

(2) Assumes antecedent moisture condition II and hydrologic soil group B.

TABLE C-5

5 - MINUTE UNIT HYDROGRAPHS

Time In Hours	Area 4-1cd	Area 4-1b	Area 4-1a	Area 4-2c	Area 4-2b	Area 4-2a	Area 4-3	Area 4-4	Courthouse Area South Area	Courthouse Area North Area	Lake Area
0.000	0	0	0	0	0	0	0	0	0	0	0
0.083	20	16	6	28	17	16	18	7	2	0	6
0.167	58	50	19	85	56	47	58	20	5	1	18
0.250	119	103	37	181	105	98	118	41	10	1	17
0.333	196	159	63	262	123	153	154	68	15	2	9
0.417	248	186	93	290	113	182	157	87	17	3	5
0.500	264	187	116	278	88	184	135	93	16	4	2
0.583	255	167	129	238	56	168	102	92	14	5	1
0.667	227	139	131	182	38	142	68	82	10	5	1
0.750	189	101	128	126	26	106	47	69	7	6	0
0.833	141	73	117	92	17	77	34	53	5	6	
0.917	105	54	104	68	12	57	23	39	4	6	
1.000	80	41	88	50	8	44	16	30	3	6	
1.083	63	31	69	36	5	33	12	24	2	6	
1.167	48	23	55	27	4	25	8	18	2	5	
1.250	37	17	44	19	2	18	6	14	1	5	
1.333	28	13	36	14	2	14	4	11	1	4	
1.417	22	9	30	10	1	10	3	8	1	4	
1.500	17	7	25	8	1	8	2	6	0	3	
1.583	13	5	20	6	0	6	1	5		3	
1.667	10	4	16	4		4	1	4		2	
1.750	7	3	13	3		3	1	3		2	
1.833	6	2	11	2		2	0	2		2	
1.917	4	2	9	2		2		2		2	
2.000	3	1	7	1		2		1		1	
2.083	3	1	6	1		1		1		1	
2.167	2	1	5	0		1		1		1	
2.250	2	0	4			0		1		1	
2.333	1		3					0		1	
2.417	1		3							1	
2.500	0		2							1	
2.583			2							1	
2.667			1							0	
2.750			1								
2.833			1								
2.917			1								
3.000			1								
3.083			0								

TABLE C-6

RUNOFF HYDROGRAPHS FOR PORTION OF COURTHOUSE LAKE AREA TO BE DIVERTED TO STAGE 4 INTERCEPTOR
(Courthouse Lake - South)

Time	Theoretical Events									Historical Events					
In Hr.Min	40%	20%	10%	4%	2%	1%	0.2%	0.1%	SPS	July 26-27 1949	July 21 1951	July 7-8 1955	August 7-8 1984	July 21 1987	July 1-2 1992
1 10											0			0	
20											1			1	
30											4	0		3	
40											8	1		7	
50										0	13	2		11	
2 0										1	16	3		14	
10										1	18	4		16	
20								0		2	15	3		14	
30							0	1		4	10	2		10	
40				0	0	0	1	1		5	6	1		7	
50		0	0	1	1	1	3	2		6	4	1		6	
3 0	0	1	1	2	2	3	7	5	0	6	3	1		5	
10	2	3	5	7	8	10	13	16	1	7	2	1		4	0
20	6	8	11	14	18	21	21	32	1	10	2	0	0	4	1
30	7	10	13	17	20	24	24	36	2	13	2		1	3	3
40	6	8	11	14	17	20	22	29	3	15	1		2	3	6
50	5	6	8	10	12	14	17	20	3	17	0		3	3	8
4 0	3	4	6	7	8	10	12	14	4	18			3	3	11
10	3	3	4	5	6	7	9	10	5	18			4	3	12
20	2	3	3	4	5	5	6	7	5	15		0	3	3	11
30	2	2	3	3	4	4	5	6	6	10		1	2	4	10
40	1	2	2	3	3	4	4	5	7	6		1	2	4	9
50	1	1	2	2	3	3	3	4	7	4		1	1	5	8
5 0	1	1	2	2	2	2	3	3	8	3		1	1	5	8
10	1	1	1	2	2	2	2	3	9	3		2	2	5	8
20	1	1	1	2	2	2	2	2	9	2		3	4	6	6
30	1	1	1	1	2	2	2	2	10	1		5	8	7	5
40	1	1	1	1	1	2	2	2	10	1		6	11	8	3
50	1	1	1	1	1	1	2	2	11	0		7	14	8	3
6 0	1	1	1	1	1	1	2	2	14			8	15	9	2
10	1	1	1	1	1	1	1	2	25			8	15	9	2
20	0	1	1	1	1	1	1	1	39			7	13	10	1
30		0	0	0	1	1	1	1	42			6	9	12	1
40					0	0	0	0	32			4	6	13	0
50									24			4	4	13	
7 0									19			3	3	14	
10									16			4	3	13	
20									14			6	2	11	
30									13			9	1	8	
40									13			1	1	6	
50									12			12	0	5	
8 0									11			13		4	
10									11			13		4	
20									11			10		3	
30									10			7		3	
40									10			4		2	
50									10			3		2	
9 0									9			2		2	
10									9			1		1	
20									7			1	0	1	
30									6			1	1	1	
40									4			0	1	0	
50									4				1		
10 0									3				1		

Time In Hr.Min	SPS	August 7-8 1984
10 10	3	1
20	3	2
30	3	2
40	3	2
50	2	3
11 0	2	3
10	2	3
20	2	2
30	2	2
40	2	1
50	2	1
12 0	2	1
10		1
20		1
30		0
40		0
50		1
13 0		1
10		1
20		0

TABLE C-7

RUNOFF HYDROGRAPHS FOR PORTION OF COURTHOUSE LAKE AREA TO BE DIVERTED INTO EAST CREEK
(Courthouse Lake - North)

	Theoretical Events									Historical Events					
Time In Hrs.Min	40%	20%	10%	4%	2%	1%	0.2%	0.1%	SPS	July 26-27 1949	July 21 1951	July 7-8 1955	August 7-8 1984	July 21 1987	July 1-2 1992
1 20														0	
30											0			1	
40											1			1	
50											3	0		2	
2 0											5	1		4	
10										0	7	1		6	
20										1	8	2		8	
30										1	10	2		9	
40								0		2	10	2		9	
50						0	0	1		2	9	2		9	
3 0			0	0	0	1	1	1		3	8	2		8	
10	0	0	1	1	1	2	2	3		4	7	2		7	
20	1	1	2	2	3	3	4	5	0	4	5	1		6	0
30	2	2	3	4	5	6	7	9	1	5	4	1		5	1
40	3	4	5	6	8	9	10	14	1	7	4	1	0	5	1
50	3	5	6	8	9	11	13	16	1	8	3	1	1	4	2
4 0	4	5	7	8	10	12	14	18	2	10	3	1	1	4	3
10	4	5	7	8	10	12	14	17	2	11	3	0	2	3	5
20	4	5	6	8	9	11	12	16	3	12	3		2	3	6
30	3	4	6	7	8	9	11	14	3	12	3		2	3	7
40	3	4	5	6	7	8	9	11	4	12	2	0	2	3	8
50	2	3	4	5	6	7	7	9	4	11	2	1	2	3	8
5 0	2	3	3	4	5	6	6	8	5	9	2	1	2	3	8
10	2	2	3	3	4	5	5	7	5	8	1	1	2	4	8
20	2	2	2	3	4	4	4	5	6	6	1	1	2	4	7
30	1	2	2	3	3	3	4	5	6	5	1	1	2	4	7
40	1	1	2	2	3	3	3	4	7	4	1	2	3	5	6
50	1	1	2	2	2	3	3	3	7	3	0	3	5	5	5
6 0	1	1	1	2	2	2	2	3	8	2		4	6	6	5
10	1	1	1	2	2	2	2	3	10	2		4	8	6	4
20	1	1	1	1	2	2	2	2	12	1		5	9	7	3
30	1	1	1	1	1	1	2	2	16	1		5	10	7	3
40	1	1	1	1	1	1	1	2	19	1		5	9	8	2
50	1	1	1	1	1	1	1	1	22	1		5	9	8	2
7 0		0	1	1	1	1	1	1	22	0		5	8	9	1
10			0	1	1	1	1	1	22			4	6	10	1
20					0	0	1	1	20			4	5	10	1
30								0	18			4	4	10	1
40									16			5	3	9	0
50									15			6	3	8	
8 0									14			7	2	8	
10									13			8	2	7	
20									12			8	1	6	
30									11			9	1	5	
40									10			8	1	4	
50									10			7	1	4	
9 0									9			6	0	3	
10									9			5		3	
20									9			4		2	
30									8			3		2	
40									7			3		2	
50									6			2	0	1	
10 0									6			2	1	1	

Runoff Hydrographs (Cont.)

Time In Hrs.Min	SPS	July 7-8 1955	August 7-8 1984	July 21 1987
10 10	5	1	1	1
20	4	1	1	1
30	4	1	1	0
40	3	1	1	
50	3	0	1	
11 0	3		1	
10	3		2	
20	2		2	
30	2		2	
40	2		2	
50	2		2	
12 0	2		1	
10			1	
20			1	
30			1	
40			1	
50			1	
13 0			1	
10			1	
20			1	
30			1	
40			0	

TABLE C-8

RUNOFF HYDROGRAPHS FOR RUNOFF INTO COURTHOUSE LAKE
(Courthouse Lake- Lake)

Time In Hr.Min	Theoretical Events 40%	20%	10%	4%	2%	1%	0.2%	0.1%	SPS	Historical Events July 26-27 1949	July 21 1951	July 7-8 1955	August 7-8 1984	July 21 1987	July 1-2 1992
1 10															
20											0			0	
30											2			2	
40											4			3	
50											6	0		5	
2 0											8	1		6	
10										0	5	1		5	
20										1	2	0		3	
30										1	1			2	
40								0		1	1			2	
50				0	0	0	0	1		2	1			1	
3 0	0	0	0	1	1	3	2	4		2	1			1	
10	1	2	4	6	8	12	15	20		4	1			1	
20	2	3	5	7	10	10	12	17		5	1			1	0
30	1	2	3	4	5	6	7	9	0	6	1			1	1
40	1	1	2	2	3	4	4	5	1	7	1		0	1	2
50	1	1	1	2	2	2	3	3	1	8	1		1	1	3
4 0	1	1	1	1	2	2	2	3	1	8	1		1	1	4
10	0	1	1	1	1	1	2	2	2	5	1		1	1	4
20		1	1	1	1	1	1	2	2	2	0		0	2	3
30		0	1	1	1	1	1	2	2	1				2	3
40			1	1	1	1	1	1	3	1				2	3
50			0	1	1	1	1	1	3	1				2	3
5 0				1	1	1	1	1	3	1		0	0	2	3
10				1	1	1	1	1	3	1		1	2	3	2
20				1	1	1	1	1	4	0		2	3	3	1
30				0	1	1	1	1	4			2	5	4	1
40					1	1	1	1	4			3	5	4	1
50					1	1	1	1	5			3	6	4	1
6 0					0	0	1	1	10			3	7	4	1
10							0	0	27			2	5	5	0
20									21			1	2	6	
30									11			1	1	6	
40									8			1	1	6	
50									7			1	1	6	
7 0									6			1	1	6	
10									6			3	0	4	
20									6			4		3	
30									6			5		2	
40									5			6		2	
50									5			6		2	
8 0									5			6		2	
10									5			4		1	
20									5			1		1	
30									5			1		1	
40									4			0		1	
50									4					1	
9 0									4					1	
10									3					0	
20									2						
30									2						
40									1						
50									1						
10 0									1						

Time In Hr.Min	SPS
10 10	1
20	1
30	1
40	1
50	1
11 0	1
10	1
20	1
30	1
40	1
50	1
12 0	1

TABLE C-9

EAST CREEK RUNOFF HYDROGRAPHS AT POINT OF DIVERSION

TIME IN HOURS	EAST CREEK INFLOW IN CFS. PROJECT CONDITIONS (1) — Theoretical Events: Frequency Of Events In Percent 10	4	2	1	0.2	0.1 (3)	SPS	Historical Event July 1987	ESTIMATED DISCHARGE IN CFS. THROUGH PROPOSED 48-INCH RCP WITH INLET INVERT AT ELEVATION 771.0 (2) — Theoretical Events: Frequency Of Events In Percent 10	4	2	1	0.2	0.1	SPS	Historical Event July 1987
0.0	0	0	0	0	0	0	50	0	0	0	0	0	0	0	50	0
0.5	10	15	10	5	5	6	55	8	10	15	10	5	5	6	55	8
1.0	15	20	15	10	10	11	55	267	15	20	15	10	10	11	55	110
1.5	20	22	20	15	15	17	60	804	20	22	20	15	15	17	60	131
2.0	25	25	25	20	20	23	70	729	25	25	25	20	20	23	70	129
2.5	30	27	30	25	25	28	75	527	30	27	30	25	25	28	75	123
3.0	35	30	35	30	30	34	80	371	35	30	35	30	30	34	80	116
3.5	45	35	45	40	40	45	120	468	45	35	45	40	40	45	96	121
4.0	55	40	60	50	50	57	150	542	55	40	60	50	50	57	99	124
4.5	70	55	70	55	60	68	175	787	70	55	70	55	60	68	102	131
5.0	80	70	90	60	75	85	190	681	80	70	90	60	75	85	104	128
5.5	100	80	110	70	90	102	180	576	94	80	95	70	90	71	102	125
6.0	120	110	130	100	105	119	170	525	96	95	97	94	94	95	101	123
6.5	140	120	150	120	120	136	150	491	98	96	99	96	96	97	99	122
7.0	170	135	175	140	135	153	130	466	101	97	102	98	97	99	97	121
7.5	200	170	210	160	150	170	130	445	105	101	106	100	99	101	97	120
8.0	240	190	215	175	170	193	130	424	108	104	107	102	101	104	97	119
8.5	253	210	250	195	190	215	130	403	109	106	109	104	104	106	97	118
9.0	260	260	265	220	215	244	130	384	110	110	110	107	107	108	97	117
9.5	750	310	290	250	240	272	130	367	130	113	112	109	108	110	97	116
10.0	2850	340	325	285	275	311	175	350	169	115	114	111	111	113	102	115
10.5	2950	1020	370	325	315	357	225	334	170	138	116	114	113	115	108	114
11.0	2000	3420	425	370	360	408	275	317	157	175	119	116	116	118	111	113
11.5	1350	3480	520	420	410	464	320	302	146	176	123	119	119	121	113	112
12.0	920	2500	1250	475	465	527	350	288	135	165	144	121	121	123	115	111
12.5	820	1550	3825	590	525	595	375	276	132	150	179	125	123	125	117	111
13.0	770	1190	3810	1480	750	850	400	265	130	142	179	148	130	133	118	110
13.5	750	1020	2875	4250	1250	1416	420	253	130	138	169	164	144	147	119	109
14.0	760	930	1825	3430	4900	5550	430	241	130	135	154	175	189	195	120	108
14.5	755	910	1450	3730	4050	4587	445	229	130	135	148	178	182	188	120	108
15.0	745	905	1230	2300	4300	4871	460	215	130	135	143	162	184	190	121	107
15.5	740	900	1140	1775	2750	3115	475	202	130	134	141	153	168	174	121	105
16.0	720	895	1120	1550	2275	2577	630	189	129	134	140	150	162	168	126	104
16.5	690	890	1090	1400	2070	2345	1070	178	128	134	140	148	158	165	139	102
17.0	670	880	1070	1320	1950	2209	1550	166	128	134	139	145	156	163	150	101
17.5	620	870	1035	1270	1825	2067	2000	156	126	133	138	144	154	161	157	100
18.0	550	840	1005	1225	1720	1948	2400	149	124	133	138	143	152	159	164	99
18.5	490	760	975	1185	1620	1835	2875	145	122	130	137	142	151	157	169	98
19.0	450	670	935	1150	1530	1733	5600	141	120	128	135	141	149	155	194	98
19.5	410	610	885	1120	1450	1642	5500	135	119	126	134	140	148	153	193	97
20.0	380	550	820	1080	1360	1540	5500	130	117	124	132	140	146	152	193	97

TIME IN HOURS	EAST CREEK INFLOW IN CFS. PROJECT CONDITIONS (1) — Theoretical Events: Frequency Of Events In Percent 10	4	2	1	0.2	0.1 (3)	SPS	Historical Event July 1987	ESTIMATED DISCHARGE IN CFS. THROUGH PROPOSED 48-INCH RCP WITH INLET INVERT AT ELEVATION 771.0 (2) — Theoretical Events: Frequency Of Events In Percent 10	4	2	1	0.2	0.1	SPS	Historical Event July 1987
20.5	340	500	715	1050	1250	1416	5580	124	115	122	127	139	144	150	194	96
21.0	310	470	650	950	1140	1291	5000	118	113	121	127	136	141	147	189	96
21.5	288	430	590	840	1090	1235	4350	113	111	120	125	133	140	144	184	96
22.0	265	400	550	770	960	1087	3625	108	110	118	124	130	136	140	177	95
22.5	242	380	505	710	875	991	2850	104	109	117	122	129	134	137	169	95
23.0	220	370	470	650	800	906	2400	99	107	116	121	127	131	135	164	94
23.5		360	430	590	760	861	2080	94		116	120	125	130	133	158	94
24.0		340	405	554	700	793	1900			115	118	124	128	131	155	
24.5		330	375	510	650	736	1800			114	117	122	127	129	154	
25.0		320	350	470	610	691	1700			113	115	121	126	128	152	
25.5		310	330	430	570	646	1620			113	114	120	124	127	151	
26.0		300		395	525	595	1585			112		118	123	126	150	
26.5		290		370	490	555	1540			112		116	122	124	149	
27.0		280		340	450	510	1480			111		115	120	123	148	
27.5		270		315	420	476	1400			110		113	119	121	147	
28.0		260		290	390	442	1300			110		112	117	120	145	
28.5		255		270	370	419	1175			109		110	116	119	142	
29.0		245		240	340	385	1080			109		108	115	117	140	
29.5				220	325	368	1000					107	114	116	137	
30.0				195	310	351	960					104	113	115	136	
30.5				180	285	323	870					102	111	113	133	
31.0				160	270	306	825					100	110	113	132	
31.5				130	260	295	775					97	110	112	131	
32.0					250	283	725						109	111	129	
32.5							680								128	
33.0							650								127	
33.5							610								126	
34.0							575								125	
34.5							540								123	
35.0							520								123	
35.5							490								122	
36.0							465								121	
36.5							440								120	
37.0							420								119	
37.5							390								117	
38.0							380								117	
38.5							360								116	
39.0							340								115	
39.5							330								114	
40.0							320								113	

(1) Inflow rates obtained from Chaska Phase I General Design Memorandum Plates 4-33A through 4-38A.
(2) Assumes no storage volume upstream of point of diversion and a Manning's "n" of 0.014.
(3) Based on ratio of peak inflow rates and 6-hour precipitation rates for 10-, 4-, 2-, 1-, and 0.2-percent rainfall events. (See paragraph 21 for further details.)

TABLE C-10

RUNOFF HYDROGRAPHS FROM EAST CREEK WATERSHED
(Courthouse Lake Watershed Not Included)

Time Hr	Min	Theoretical Events 10%	4%	2%	1%	0.2%	0.1%	SPS	Historical Event July 21 1987
0	0	0	0	0	0	0	0	50	0
	10	2	2	2	1	1	1	50	2
	20	2	3	2	1	1	1	50	2
	30	4	5	4	2	2	2	51	2
	40	7	10	7	3	3	4	53	3
	50	10	14	10	5	5	7	55	7
1	0	12	18	13	8	8	10	58	16
	10	14	20	16	11	12	15	61	38
	20	17	24	20	14	16	20	64	89
	30	21	26	24	18	21	25	67	184
	40	24	29	28	22	25	31	71	312
	50	28	33	32	27	30	37	75	443
2	0	32	36	37	33	36	44	80	560
	10	36	41	43	40	41	51	85	645
	20	42	46	50	47	48	60	90	676
	30	48	52	58	55	57	71	95	679
	40	56	60	68	65	70	89	98	678
	50	68	73	86	87	96	124	102	677
3	0	96	105	128	139	158	207	107	665
	10	191	221	269	310	358	465	114	627
	20	367	439	529	615	711	914	130	565
	30	513	618	745	871	1009	1297	158	497
	40	589	701	856	1010	1176	1521	193	437
	50	586	716	880	1044	1220	1585	230	392
4	0	549	664	824	974	1136	1473	265	359
	10	484	576	717	835	968	1246	301	340
	20	407	475	592	676	775	989	340	334
	30	340	388	482	538	609	772	379	338
	40	289	324	400	437	488	614	420	347
	50	253	278	341	363	402	503	463	360
5	0	226	246	300	309	343	426	508	377
	10	206	223	272	269	302	372	553	400
	20	192	207	250	239	272	332	595	433
	30	184	195	233	217	252	302	636	470
	40	179	187	220	202	239	279	680	506
	50	174	182	210	192	229	262	732	538
6	0	170	179	202	188	220	249	830	568
	10	165	177	194	187	211	237	1089	605
	20	157	171	184	181	199	222	1496	655
	30	148	160	170	169	183	203	1837	711
	40	138	147	156	154	166	182	2043	763
	50	128	134	142	140	148	161	2091	811
7	0	120	124	130	128	134	143	1954	857
	10	114	116	122	119	123	130	1713	888
	20	110	111	116	114	116	121	1475	886
	30	108	108	113	110	112	117	1295	862
	40	108	107	112	109	110	114	1173	825
	50	108	107	111	108	108	113	1092	781
8	0	108	107	110	108	108	112	1036	724

Time Hr	Min	Theoretical Events: 10%	4%	2%	1%	0.2%	0.1%	SPS	Historic Event July 21 1987
8	10	108	107	110	108	108	113	992	652
	20	108	108	110	108	108	113	967	570
	30	109	108	111	108	108	114	955	492
	40	109	109	111	108	108	114	942	427
	50	109	109	111	109	109	115	929	379
9	0	109	110	112	109	109	115	916	342
	10	109	110	112	110	110	116	897	309
	20	111	111	112	110	111	117	857	278
	30	115	111	112	111	111	118	795	249
	40	121	112	112	111	112	118	718	225
	50	128	113	113	112	112	119	633	206
10	0	137	113	113	112	113	120	556	189
	10	148	114	114	113	113	121	495	173
	20	156	116	115	113	113	122	450	159
	30	159	121	115	114	114	123	419	147
	40	160	127	116	115	114	123	395	138
	50	160	135	117	115	115	124	377	131
11	0	156	145	117	116	116	125	362	127
	10	152	157	118	116	116	126	350	124
	20	147	166	119	117	117	127	340	121
	30	143	169	120	118	118	128	332	120
	40	140	170	121	118	119	129	325	119
	50	137	169	123	119	120	130	320	118
12	0	135	165	127	119	120	131	316	118
	10							310	118
	20							297	117
	30							278	117
	40							255	117
	50							230	116
13	0							208	116
	10							190	116
	20							178	116
	30							170	115
	40							165	115
	50							161	115
14	0							158	115
	10							156	115
	20							154	115
	30							152	114
	40							151	114
	50							150	114
15	0							149	114
	10							147	114
	20							146	113
	30							146	113
	40							145	113
	50							144	113
16	0							144	112

TABLE C-11

RUNOFF HYDROGRAPHS FROM EAST CREEK WATERSHED DURING
PERIODS WHEN MINNESOTA RIVER WAS ABOVE ELEVATION 706.0
(Courthouse Lake Watershed Not Included)

Time	Historical Event:												
Hr Min	Jun 4	Jun 5	Jul 3	May 7	Apr 5	Aug 29	Jul 4	Jul 10	Jun 16	Jul 1	Jul 1	Jul 3	Jul 3
	1944	1944	1957	1965	1967	1979	1983	1984	1993	1993	1993	1993	1993
	Hour	Hour	Hour	Hour	Hour	Hour	Hour	Hour	Hour	Hour	Hour	Hour	Hour
	22	16	5	22	17	14	13	7	1	1	21	1	16
0 0	0	0		0		0	0	0			0		
10	0	0		0		0	0	0			1		
20	1	1		1		1	5	1			9		0
30	8	6		4		6	20	6	0		38	0	1
40	21	18		12	0	16	47	18	1		89	2	4
50	37	33		24	1	30	81	32	2		152	5	9
1 0	53	48		35	3	43	115	47	5		216	9	15
10	65	60	0	47	6	53	143	58	7		269	14	20
20	71	68	4	65	8	55	150	62	9		286	26	21
30	69	72	17	96	10	49	136	56	11		265	49	17
40	64	73	38	133	13	41	115	47	14		223	77	11
50	60	76	62	166	15	36	95	40	16		171	107	6
2 0	59	80	86	192	17	32	79	36	18		120	135	4
10	58	87	107	218	18	32	64	33	19		78	159	2
20	55	102	118	236	20	40	51	29	18	0	48	167	1
30	49	126	117	239	24	57	39	23	17	1	30	161	1
40	44	153	114	232	30	77	28	17	15	4	19	148	0
50	39	181	112	221	38	96	20	13	14	8	12	135	
3 0	35	207	113	209	46	114	13	10	13	12	8	122	
10	32	232	115	198	53	129	8	8	13	15	5	110	
20	28	258	114	183	60	127	5	12	13	18	3	96	
30	22	285	110	162	64	111	3	22	13	20	2	78	
40	17	311	105	139	65	88	2	33	12	23	2	59	
50	12	336	101	115	64	65	1	43	11	25	1	42	
4 0	8	359	98	95	64	44	1	51	11	27	1	28	
10	5	373	94	79	64	28	1	62	12	29	1	18	
20	3	362	86	69	64	18	0	85	16	28	1	11	
30	2	325	73	64	62	11		123	25	26	1	7	
40	1	274	58	63	56	7		166	36	23	1	5	
50	1	218	45	63	50	5		210	46	20	1	3	
5 0	1	166	32	65	43	3		251	54	18	1	2	
10	0	125	23	65	35	2		283	61	17	1	2	
20		93	15	62	26	1		295	63	15	1	1	
30		68	10	54	19	1		284	55	12	1	1	
40		49	7	44	13	1		260	45	9	1	1	
50		34	5	33	8	1		230	36	7	1	1	
6 0		23	3	23	5	0		202	29	6	1	1	
10		17	2	15	3			177	24	4	1	1	
20		16	2	10	2			151	24	4	1	1	
30		21	1	7	1			123	27	4	1	1	
40		28	1	5	1			95	33	3	1	1	
50		37	1	4	1			68	38	3	1	1	
7 0		44	1	3	0			46	43	3	1	1	
10		48	1	3				30	46	3	1	1	
20		46	1	2				19	45	4	1	1	
30		40	1	2				13	41	7	1	1	
40		32	1	2				9	36	10	1	1	
50		24	1	2				6	30	11	1	1	
8 0		17	1	2				5	26	13	1	1	

Time	Historical Event:			
Hr Min	Jun 5	Jul 10	Jun 16	Jul 1
	1944	1984	1993	1993
	Hour	Hour	Hour	Hour
	16	7	1	1
8 10	12	4	23	14
20	9	3	21	13
30	7	3	21	10
40	6	3	21	7
50	5	2	22	5
9 0	4	2	22	3
10	4	2	23	2
20	4	2	23	1
30	4	2	24	1
40	4	2	25	0
50	4	2	26	
10 0	4	2	26	
10	4	2	28	
20	4	2	30	
30	4	2	34	
40	4	2	40	
50	4	2	45	
11 0	4	2	49	
10	4	2	53	
20	4	2	56	
30	4	2	58	
40	3	2	59	
50	3	2	61	
12 0	3	2	62	
10	3	2	64	
20	3	2	66	
30	3	2	65	
40	3	2	63	
50	3	2	59	
13 0	3	2	56	
10	3	2	52	
20	3	2	46	
30	3	2	40	
40	3	2	34	
50	3	2	29	
14 0	3	2	25	
10	3	2	22	
20	3	2	19	
30	3	2	16	
40	3	2	13	
50	3	2	10	
15 0	3	2	7	
10	3	2	5	
20	3	2	3	
30	3	2	3	
40	3	2	2	
50	3	2	2	
16 0	3	2	1	

22. The size of each sub-watershed and estimated ground slopes (presented in Table C-4) used to obtain time of concentrations were obtained from USGS quad sheets. Time of concentrations were obtained using Worksheet 3 of TR55. The two-year, 24-hour rainfall amount for Chaska was obtained from Figure III-1b, page III-8 of the National Weather Service publication "Hydro - 35." Lag time was assumed to be equal to 60 percent of the time of concentration as defined on page 15-6, SCS National Engineering Handbook, Section 4, "Hydrology." The SCS curve numbers based on existing conditions were obtained based on a soil group B and an antecedent moisture condition II, then increased 10 percent to account for future development. It is assumed all local rainfall runoff will occur simultaneously with a like frequency event on East Creek upstream of the proposed point of diversion.

SEEPAGE

23. Seepage is not considered to be significant in the stage 3 (East Creek) area.

RECOMMENDED INTERIOR FLOOD CONTROL PLAN

GENERAL

24. The recommended interior flood control plan will consist of a gated gravity inlet (Outlet E) with flared end section and preformed scour hole at the point of diversion, a gated gravity outlet with concrete apron and preformed scour hole at Outlet D, three designated ponding areas, and a portable 5,000 gpm pump with power take-off located on top of the berm at the upstream end of Outlet D with discharge into Gatewell D. The required facilities are further defined in the following paragraphs.

GRAVITY OUTLETS

25. Outlet E will consist of a 48-inch RCP, about 269 feet long, with gatewell, flared end section, an inlet invert elevation of 771.0 and an outlet invert elevation of 770.0. The structure is to be constructed as part of the overflow weir structure required to divert excess runoff from East creek into the proposed diversion channel. (The proposed diversion channel is discussed in Appendix B.) To prevent channel scouring downstream from the inlet structure, a preformed scour hole with a 8-foot by 12-foot base at elevation 768.0, 1 on 3 side slopes (as shown on Plate C-14), and an 18-inch layer of riprap will be required.

26. Outlet D will consist of a 84-inch RCP, about 197 feet long, with a gatewell, and an invert elevation of 699.0. To prevent scour or erosion adjacent to this structure, a 12-inch bed of riprap will be required at the upstream end and a 25-foot by 19-foot, 10-inch concrete apron, and preformed scour hole with a 27-inch bed of riprap will be required at the downstream end. The upstream riprap bed will extend upstream of the entrance to the

pipe about 20 feet, extend laterally in each direction to the top of the existing creek bank, and extend up the side of the levee to elevation 717.0, and laterally in both directions about 14 feet from the pipe centerline. The proposed preformed scour hole will be constructed as shown on Plate C-14 with a 14-foot by 21-foot base at elevation 695.5 and 1 on 3 side slopes.

RIPRAP REQUIREMENTS

27. Based on a stone specific weight of 165 pounds per cubic foot, the required riprap specifications are as follows:

Location:	Scour Holes Downstream of				Adjacent to	
	Outlet E		Outlet D		Outlet D	
Thickness (Inches):	18		27		12	
Percent Lighter	Limits of Stone Weight in Pounds:					
By Weight:	Max.	Min.	Max.	Min.	Max.	Min.
100	86	35	292	117	26	10
50	36	17	123	58	11	5
15	18	5	62	18	5	2

DESIGNATED PONDING AREAS

28. Under proposed conditions, there are to be three designated ponding areas: the lower area located adjacent to Outlet D referred to as the Outlet D ponding area; Courthouse Lake; and the low area located north and west of East Creek and east of Highway 41 referred to as the Old Clay Hole. The location of these designated ponding areas is shown on Plates C-1, and C-2. Elevation-area-storage relationships for each of these areas are presented on Plate C-3.

29. The required volume of storage in the Old Clay Hole is about 23 acre feet between elevations 727.0 and 728.5 (for a 1-percent event). The required storage in Courthouse Lake is about 5.2 acre feet between elevations 703.0 and 703.4 (1% event, see Table C-14, page C-26). The required storage in the Outlet D area, based on the estimated runoff from a one percent event, is about 44 acre feet between elevations 700.0 and 711.7. Easements to the 1-percent level are required adjacent to each of the three designated ponding areas to prevent encroachment and development within the designated ponding areas. It is also recommended that local interests maintain the existing ponding areas to prevent the potential for future flood damage downstream. The estimated amount of real estate required at the Old Clay Hole, Courthouse Lake, and Oulet D Pond sites will be about 15, 12, and 11 acres, respectively. The sides of the ponding areas are to be graded, topsoiled, and seeded to permit proper maintenance of the areas. Also, ponding markers are to be added as required.

PLAN OF OPERATION

30. During low flows on the Minnesota River (gravity flow conditions), the sluice gates in gatewells D and E will be open. Runoff from East Creek upstream of the point of diversion up to about 92 Cfs. (as indicated on Plate C-19) will discharge through Outlet E, the protected area and Outlet D into the Minnesota River. When the discharge rate in East Creek at the point of diversion exceeds 92 cfs, runoff will discharge both through Outlet E and over the overflow embankment into the diversion channel. Runoff from the Courthouse Lake-South area will discharge through the new stormsewer constructed by the city to the Stage 4 interceptor and into the Minnesota River. Except for the area immediately adjacent to Courthouse Lake, runoff from the remaining area located within the protected area will flow into East Creek and through Outlet D into the Minnesota River. Unless the level of Courthouse Lake rises above elevation 706.7, there will be no runoff from the lake into East Creek.

31. During flood periods when the Minnesota River at the Highway 41 bridge equals or exceeds elevation 706.0, the sluice gate in gatewell E will be closed to prevent any further inflow from East Creek. When and if the Minnesota River at Highway 41 equals or exceeds elevation 709.0, the sluice gate in gatewell D will be closed until the river recedes below the same elevation. Should the recorded rainfall accumulate to more than one inch after the closure of outlet D, portable pumping facilities should be installed and operated if the interior pond level rises above elevation 710.0. If during a flood period the level of Pond D rises above the level of the Minnesota River, or the Minnesota River recedes below the level of Pond D, the city may elect to temporarily open outlet D to lower the pond level. When the Minnesota River recedes below elevation 709.0 at the Highway 41 bridge, the gate on Outlet D should be opened. The gate on Outlet E will be opened when the Minnesota River recedes below elvation 706.0. The City of Chaska may elect to close the gate in Gatewell E more frequently, such as during the winter season to prevent the build up of ice in the creek adjacent to the Crosstown Boulevard bridge. This operating plan will be incorporated into the operation and maintenance manual.

PROJECT JUSTIFICATION

DEPARTURES FROM GENERAL DESIGN MEMORANDUM, SUPPLEMENT NO.2

32. The proposed plan recommended above includes two changes from the recommended plan presented in the earlier reports. The proposed location for Outlet D is about the same as previously indicated, however, the recommended size has been greatly reduced from a twin 108-inch Rcp to only a single 84-inch Rcp. The replacement of the existing 18-inch culvert between Courthouse Lake and East Creek with a new 48-inch Rcp, recommended in the earlier reports, is no longer required.

33. The change in recommended size of Outlet D is the result of modifications to the HEC-1 and HEC-2 programs used to determine the volume of runoff and upstream profiles. The HEC-1 model for determining the runoff from the interior watershed located downstream of the point of diversion was originally developed in 1983. This model used the SCS methodology of rainfall-runoff computations, but assumed only one unreasonably high runoff curve number (CN) of 92 for the entire watershed, and assumed wet antecedent moisture conditions (AMC III). (A curve number of 92 is used where an entire watershed is developed into a business and industrial district.) In the current study, the HEC-1 hydrological model, as presented in Table C-4 (page C-10), was updated using more reasonable curve numbers taking into account soil type, residential development, and average antecedent moisture conditions (AMC II), resulting in lower runoff volumes. Also in the current study, runoff from areas 4-2b and 4-2c is assumed to flow into the Old Clay Hole and routed through the existing stormsewer to East Creek; whereas in earlier studies, runoff from these areas was assumed to discharge directly unrestricted into East Creek. In this study the estimated inflow through Outlet E, during gravity flow conditions, was based on the appropriate inflow hydrographs presented in Table C-9 (page C-15) instead of assuming a constant inflow rate of 80 cfs.

34. Since the last interior runoff study, additional channel cross-section data has been obtained along East Creek upstream of the Highway 212 crossing and incorporated into the HEC-2 model. The additional cross-sections were obtained because of deposition near the highway bridge and development in the floodplain since when the original cross-sections were obtained. (The HEC-2 model for East Creek downstream of the proposed point of diversion, used for the earlier interior studies, included cross-sections upstream of the Highway 212 crossing developed from USGS quad sheets).

GRAVITY OUTLETS

35. An 84-inch RCP was selected as the size of Outlet D to limit the maximum interior pond level during a 0.1-percent rainfall event to 715.0. In the Limited Reevaluation Report ..., dated August 1982 (reference 61p), it indicates that overflow from East Creek into Courthouse Lake should not occur more frequently than about once every 1000 years; and the lowest elevation on the levee separating the lake from the creek is 715.0. An elevation-head-discharge curve for Outlet D is presented on Plate C-16.

36. A 48-inch RCP was selected as the required size of Outlet E to permit all flows less than about 92 cfs to pass into the protected area during gravity flow conditions. (A discharge rate of 85 cfs is considered to be the mean annual flow on East Creek at that location and the rate the city requested to be the minimum allowable inflow rate on East Creek without overflow into the diversion channel). With the proposed 48-inch pipe outlet, it is

estimated that the maximum inflow to the existing creek channel during a 1-percent and Standard Project Storm will be, as indicated in Table C-9 (page C-15), about 178 and 194 cfs, respectively, which can be expected to occur during hours 14.5 and 19.0, respectively; or about the same time that local runoff to Outlet D will terminate. As indicated in Table C-10 (pages C-16 and C-17), the peak inflow rate to Outlet D for the same two rainfall events will occur at about hours 3:50 and 6:50, respectively when the estimated inflow through Outlet E will be about 50 and 97 cfs respectively. Since the maximum inflow rates through Outlet E generally will not occur until after most of the interior runoff has passed Outlet D, it does not appear that there will be a need to limit the rate of inflow through Outlet E during gravity flow conditions. Elevation-discharge curves for Outlet E are presented on Plate C-19. The curve based on a Manning's "n" of 0.012 was used for sizing of riprap required downstream of the outlet and the curve based on an "n" value of 0.014 was used for determining the design discharge rates.

SCOUR HOLES

37. A preformed scour hole will be required at the downstream end of Outlets D and E to prevent damage from erosion and scour at the pipe outlets and to possibly prevent the formation of sedimentation deposits within the pipes.

NEED FOR PORTABLE PUMPING FACILITY AT POND D

38. Prior to the 1993 flood on the Minnesota River at Chaska, there would have been no need to provide a pumping facility adjacent to Outlet D to remove interior runoff during periods of blocked gravity drainage. However, with the long period of high river levels and the five periods of intense rainfall during this time, it became necessary to require a pumping facility with a capacity of about 5,000 gpm to satisfactorily remove the interior runoff. Since the 1993 flood appears to be a rare event with only a small chance of reoccurring, it is recommended that only temporary pumping facilities be provided.

39. Tables C-17, C-18, and C-23 present the estimated maximum Pond D level which would occur during periods of blocked gravity drainage with and without pumping. As indicated in Table C-23, a pumping capacity of about 5 cfs would be required to keep the pond level below elevation 715.0 if the Outlet D gate is closed when the river rises above elevation 709.0 at Highway 41 as recommended. Should the city, however, mistakenly close the gate on Outlet D when the Minnesota River reaches elevation 706.0, an additional 5 cfs pumping capacity would be required to limit ponding to elevation 715.0 or less.

40. As indicated in paragraph 6 (page C-2), the top of the dike around the farmstead located north of Courthouse Lake is at about

elevation 718.1 and the floor of the enclosed farmhouse is at about elevation 716.0. Since the minimum elevation of the top of the dike separating Courthouse Lake from East Creek is about 715.0, or about one foot below the floor level to the farmhouse, there will be no need to provide additional protection to the farmstead area. Also, there are existing gate structures located on the outlets from the farmstead, and if properly operated, would prevent flood damage to the farmstead even if the Pond D level rises above elevation 716.0

ADDITION TO STAGE 4 INTERCEPTOR STORMSEWER

41. With the required subdivision of the Courthouse Lake watershed and incorporation of the proposed drainage plan suggested by the city (defined in paragraph 7, page C-2), the additional runoff from the Courthouse Lake - North watershed into East Creek will result in only a small insignificant rise in the level of the Outlet D pond; and the volume of runoff into Courthouse Lake will be greatly reduced, eliminating the need for modifications to the existing gravity outlet from the lake into East Creek. Since the proposed stormsewer from the south parking area is to be connected to the Stage 4 interceptor, a proposed plan for the sewer extension has been developed and is shown on Plate C-2 and defined in Table C-13. The recommended pipe size and invert elevations for the proposed sewer extension are presented in Table C-13 as sewer segments 15-14 and 16-15. Segment 16-15 (as shown on Plate C-2), if required, will be placed in the south parking lot along the west side of the existing levee (dike) separating the parking lot from the lake. Segment 15-14 will extend about 550 feet from the south end of the parking lot to manhole 14 of the Stage 4 interceptor. To permit the extension of the Stage 4 intercepting storm sewer to the Courthouse Lake area, Stage 4 sewer segments 13-12 and 14-13, as originally recommended, will have to be increased from 24- and 18-inch pipe to a 30- and 24-inch pipe respectively; and the recommended invert elevations for these two pipe sections will have to be lowered 6-inches. With this recommended storm sewer plan, about 0.3 and 1.6 acre feet of temporary ponding will occur in the south parking area during a 1-percent and SPS event, respectively. With this plan, the existing SPF level of 712.5 will not be exceeded and the hydraulic gradient for the 10-percent event will not rise more than two feet above the pipe crown. (As indicated in paragraph 9, (page C-3), the City of Chaska plans to design their future stormwater sewerage system based on the runoff from a 10-percent event.)

POND - FREQUENCY RELATIONSHIPS

42. Pond level - frequency curves for the three designated ponding areas are presented on Plate C-15. Tables C-14 and C-15 present the estimated maximum pond levels for Courthouse Lake and the proposed Outlet D pond for the nine theoretical and six historical rainfall events investigated, including the SPS. The elevation-

TABLE C-12

DESCRIPTION OF EXISTING STORMSEWER CONNECTING OLD CLAY HOLE TO EAST CREEK

Pipe Location (Section)	1	2	3	4
Pipe Diameter In Inches	15	18	18	18
Pipe Type	RCP	RCP	RCP	RCP
Pipe Length In Feet	143	52.1	22.2	29.1
Pipe Invert Elevation:				
Upstream	726.4	724.6	723.9	723.7
Downstream	724.6	723.9	723.7	723.28
Top Of Manhole Elevation				
Upstream End	-	729.0	729.22	727.38

TABLE C-13

PROPOSED PLAN FOR STORMSEWER EXTENSION BETWEEN COURTHOUSE LAKE AREA AND STAGE 4 INTERCEPTOR

Sewer Segment	10	11-10	12-11	13-12	14-13	15-14	16-15
Required Pipe Length-Feet	93	416	232	258	254	550	350
Required Pipe Diameter-Inches	66	48	36	30	24	18	15
Given Upstream Crown Level (1)	699.00	699.62	699.97	700.36	700.74	701.84	702.54
Upstream Invert Elevation	693.50	695.62	696.97	697.86	698.74	700.35	701.29
Standard Project Storm							
Discharge-Cfs.	266	111	64	37	12	12	-
Head-Feet	3.63	3.12	2.73	2.61	0.87	8.47	-
Hyd. Grad.	702.31	705.43	708.16	710.77	711.64	720.11	-
One Percent Event							
Discharge-Cfs.	198	87	53	37	14	14	-
Head-Feet	1.97	1.92	1.87	2.61	1.19	11.53	-
Hyd. Grad.	700.11	702.03	703.90	706.51	707.70	719.23	-
Ten Percent Event							
Discharge-Cfs.	128	58	36	26	13	13	8
Head-Feet	0.83	0.85	0.86	1.30	1.03	9.94	6.56
Hyd. Grad.	698.23	699.08	700.07	701.37	702.40	712.34	718.90

(1) Assumes a pipe slope of 0.002 feet per foot.

frequency curves for the Outlet D Pond presented in Table C -14 and on Plate C-15 were developed assuming a low Minnesota River stage; however, further studies have indicated the estimated interior pond level resulting from the same rainfall events with a Minnesota River stage of 705.3 at the mouth of East Creek will rise from about 8-inches for a 40% chance event to only about 2-inches for a 0.2% event. (The maximum pond levels were obtained from the HEC-1 computer runs using the rainfall data presented in Table C-1 and the hydrological data presented in Table C-4 (see page 10) using the curve numbers with future development. The maximum pond levels for the SPS event includes the overflow of about 164.8 acre feet from East Creek into Courthouse Lake. Note on Plate C-4 that the zero damage levels for Courthouse Lake and the proposed Outlet D pond are about 718.6 and 719.0, respectively, which are much higher than the resulting pond levels indicated on Plate C-15 and in Tables C-14 and C-15. (Therefore no economic analysis has been performed relative to this study.) Since there is more storage available in Courthouse Lake than is required to store the runoff from a SPS, there is no longer a need to modify the existing outlet to East Creek. Under present conditions, Courthouse Lake will be flooded by the Minnesota River about once every 10 years, whereas under proposed conditions, it will be flooded once in about 100 years from the Minnesota River and once in about 1,000 years from East Creek. With the proposed 84-inch pipe at Outlet D, it will, therefore, take a less frequent event on East Creek to result in flood damage to the farmstead north of Courthouse Lake.

STREAMFLOW PROFILES

43. Based on this most recent analysis, there will be no areas along East Creek between Outlet E and Outlet D located within the 1-percent (100-year) residual floodplain. As shown in Table C-16 and on Plate C-10, the residential area between Crosstown and Engler Boulevards and the developed areas located downstream of the Highway 212 bridge, which were previously located within the floodplain, will no longer be. The new East Creek residual flood outline is contained generally within the existing creek channel banks, or within non-damaging areas of the creek's floodplain. The new design 1-percent water surface elevation will have no significant impact on the Brandondale Trailer Park, because areas of the trailer park on the lower terrace adjacent to the creek will be protected by the levees, and the remainder of the trailer park is located on the upper terraces of the Minnesota River, over 20 feet above the top of the levee. A discharge-damage curve for the area located along East Creek upstream of Beech Street is presented on Plate C-5. The "without project" flooded area is outlined on Plate C-11. The floodplain near Courthouse Lake is shown on Plate C-2. Also, interior pond levels in Pond D will have little to no effect on the floodplain upstream of the Courthouse Lake area.

TABLE C-14

DETERMINATION OF POND-FREQUENCY RELATIONSHIPS FOR COURTHOUSE LAKE

Freq. Or Year Of Event	Rainfall	Rainfall Excess	Runoff In Acre Feet: Lake (12.3 Ac.)	Adjac. To Lake (4.9 Ac.)	Total	Accum. Storage (AcFt.) (*)	Max. Pond Level (**)
40-Percent	2.33	0.35	2.39	0.14	2.53	36.5	703.2
20-	2.65	0.49	2.72	0.20	2.92	36.9	703.2
10-	3.14	0.75	3.22	0.31	3.52	37.5	703.3
4-	3.57	1.00	3.66	0.41	4.07	38.1	703.3
2-	4.01	1.27	4.11	0.52	4.63	38.6	703.4
1-	4.41	1.54	4.52	0.63	5.15	39.1	703.4
0.2-	4.85	1.85	4.97	0.76	5.73	39.7	703.5
0.1-	5.75	2.52	5.89	1.03	6.92	40.9	703.6
SPS	11.15	8.05	11.43	3.29	14.72	48.7	715.9 ***
1949	4.97	1.94	5.09	0.79	5.89	39.9	703.5
1951	3.95	1.23	4.05	0.50	4.55	38.6	703.4
1955	5.33	2.20	5.46	0.90	6.36	40.4	703.5
1984	4.84	1.86	4.96	0.76	5.72	39.7	703.5
1987	7.83	4.21	8.03	1.72	9.74	43.7	703.8
1992	3.96	1.24	4.06	0.51	4.57	38.6	703.4

(*) Assumes an initial storage of 34.0 acre feet at elevavation 703.0.
(**) Assumes there is no outflow to East Creek.
(***) Includes 164.8 acre feet of overflow from East Creek.

TABLE C-15

POND-FREQUENCY DATA FOR OLD CLAY HOLE AND OUTLET D POND

Old Clay Hole: Freq. Or Year Of Event	Accum. Runoff (AcFt)	Max. Pond Level	Outlet D Pond — Maximum Pond Level Assuming Inflow From Point Of Diversion: Constant 80 Cfs.	Hydrographs Presented In Table C-9	Ratio Of Depths Above Elevation 700. (Col 2)/(Col 1)
40-Percent	4.7	727.29	706.97	706.78 *	
20-	6.9	27.43	07.93	07.72 *	
10-	10.8	27.67	09.12	08.79	0.964
4-	14.7	27.91	10.05	09.65	0.960
2-	19.0	28.21	11.00	10.73	0.975
1-	23.4	28.52	11.99	11.66	0.972
0.2-	28.5	28.88	13.06	12.71	0.973
0.1-	39.8	29.58	15.01	14.88	
SPS	92.0	32.35	16.60 **		
1949	30.8	729.03	713.07		
1951	18.7	28.19	10.96		
1955	34.6	29.27	10.78		
1984	28.7	28.75	10.58		
1987	67.2	31.10	12.80	13.43	
1992	19.0	28.21	10.36		

(*) Assumed tobe 97.3% of level obtained with a constant 80 cfs inflow. (There are no existing runoff hydrographs for these events available for East Creek upstream of the point of diversion.
(**) Adjusted to account for overflow into Courthouse Lake.

TABLE C-16

EAST CREEK WATER SURFACE PROFILES AND CROSS-SECTION INFORMATION

Cross-Section Information:							Water Surface Profiles:					
Computer Station (Upstream From Mn. River)	Channel Elevations Left Bank	Thalweg	Right Bank	Max. Low Chord	Min. Top Of Road		Existing Conditions: 1%	SPF	1987	Proposed Conditions: 1%	SPF	1987
20.90	704.0	701.0	704.0			Outlet D	713.5	713.5		711.7	716.6	713.4
24.70									708.0			
27.70	711.6	704.6	716.0			Outlet From	714.0	714.4	712.6	11.7	16.6	13.4
30.70						Courthouse Lake			714.6			
32.00	710.0	707.2	712.0				715.4	716.4		12.4	16.8	13.5
33.90									716.3			
37.60									717.4			
37.75	720.0	710.6	720.0				718.4	719.9		15.1	17.4	14.5
38.10	720.0	710.8	720.0	718.0	720.2	Beach Street	720.3	720.7	718.8	15.2	18.5	14.7
40.00	718.7	711.9	721.2				721.3	722.5		17.3	19.3	16.8
40.80									719.2			
41.00	718.7	712.9	721.2				723.1	724.5	719.4	18.4	20.8	18.0
41.01	718.7	712.9	721.2	721.2	718.7	Pedestrian Bridge	723.3	724.7	720.4	18.8	21.2	18.3
43.70	720.0	714.3	722.2				724.2	725.5	723.0	20.7	22.6	20.3
47.30	722.0	717.1	724.0				725.6	726.6	724.0	22.8	24.4	22.4
47.55	722.0	717.1	724.0				725.7	726.6	725.4	23.1	24.7	22.7
47.60	724.5	717.4	724.8	724.8	724.5	6th Street	725.7	726.7	725.9	23.0	24.6	22.6
47.85	724.3	717.4	724.8				725.9	726.8		23.1	24.9	22.7
48.75	724.0	718.0	724.0				726.2	727.0		24.1	25.4	23.6
49.90									726.9			
50.09									728.3			
50.25	724.0	719.3	724.0	725.0	733.0	Covered Walk Bdge.	727.4	728.0				
50.50	726.3	719.3	726.3			C. & NW. Ry.	727.5	728.1		24.7	26.2	24.2
50.80				726.3	728.0	Bridge	728.8	729.3	728.5	24.7	27.3	24.3
51.50	726.0	720.1	724.0				728.8	729.3		25.0	27.3	24.5
52.00	726.0	720.2	724.0				728.8	729.4		25.2	27.4	24.7
52.25	726.0	720.2	724.0	726.0	726.5	Highway 212 Bdge.	728.8	729.4	728.5	25.3	27.4	24.9
53.90									728.5			
56.00	728.0	722.4	728.0				729.9	730.6		27.7	28.9	27.2
58.30									732.8			
61.30									734.4			
62.00	732.0	726.0	732.0				734.0	734.6		31.7	32.8	31.4
64.10									735.2			
66.00	734.0	728.5	734.0				736.2	736.9		34.1	35.1	33.9
67.10									736.5			
69.00	736.0	730.0	736.0				737.8	738.4		36.0	36.9	35.7
70.10									740.1			
73.00	738.0	733.0	738.0			x	739.7	740.4		37.6	38.5	37.4
73.30						overbank rises			741.8			
75.50	740.0	734.2	750.0			x abruptly	743.0	743.9		39.9	41.5	39.5
76.30									742.9			
80.00	742.0	736.0	742.0				745.9	746.8		43.5	44.6	43.2
82.70									744.9			
83.50	746.3	737.3	745.9				746.9	747.6	747.2	44.6	45.8	44.3
84.10	745.2	740.0	745.2	744.0	744.6	Crosstown Blvd.	747.1	747.8		44.9	45.8	44.8
84.50	746.3	740.0	745.9			Bdge.	747.4	748.0		45.4	46.3	45.2

TABLE C-16 (Cont.)

EAST CREEK WATER SURFACE PROFILES AND CROSS-SECTION INFORMATION

Cross-Section Information:							Water Surface Profiles:					
Computer Station (Upstream From Mn. River)	Channel Elevations Left Bank	Thalweg	Right Bank	Max. Low Chord	Min. Top Of Road		Existing Conditions: 1%	SPF	1987	Proposed Conditions: 1%	SPF	1987
86.50									747.2			
89.50									748.6			
90.00	750.0	743.2	750.0				751.4	751.9		49.1	50.4	49.0
93.00	752.0	745.0	752.0				753.2	753.8	750.9	50.8	52.0	50.7
93.30									751.6			
96.00	754.0	746.7	754.0				755.8	756.4		52.6	54.2	52.7
96.30									753.2			
99.00	756.0	748.5	756.0				757.5	758.1		54.1	55.5	54.5
99.30									755.5			
102.00	758.0	750.2	758.0				759.5	760.0		55.2	56.8	55.6
102.30									757.7			
105.00	758.0	752.0	760.0				761.4	761.6		56.5	58.6	57.0
105.30									760.0			
108.00	760.0	753.8	762.0				763.5	764.0		57.4	59.7	58.0
108.30									762.4			
111.00	762.0	755.6	762.0				765.0	765.8		58.3	60.5	58.8
111.30									764.2			
113.20									765.3			
114.00	768.4	757.2	765.2				769.2	769.7		60.8	63.1	61.5
115.20									768.4			
116.00	768.4	759.6	765.2	769.7	773.1	Engler Blvd.	773.9	774.2		65.8	68.9	66.6
118.70						10'x10' RCB			770.2			
119.50	769.9	761.7	767.8				773.9	774.2	770.3	67.3	70.3	68.1
120.50	770.0	763.4	770.0				774.1	774.5	770.4	67.6	70.4	68.3
121.35	769.5	764.6	770.1				774.2	774.7		67.6	70.4	68.4
122.05									771.5			
122.45									772.0			
122.85	772.4	766.3	769.7				775.5	776.2		67.9	70.4	68.7
123.25	778.8	766.3	769.7	778.8	776.1	Brandon Blvd.	776.7	777.7		67.9	70.4	68.7
123.70									772.6			
124.50	780.0	767.4	776.0				777.9	778.9		68.8	70.4	69.4
125.70									775.7			
126.50	780.0	769.8	776.0				780.2	781.3		71.7	72.4	72.6
127.20									776.7			
128.00	772.2	771.4	771.9			Bike Path	782.7	783.9		-	-	-
128.25		771.4		780.9	780.9	Old 1922 Bridge	783.5	784.5		-	-	-
128.50									778.4			
129.30	783.1	772.2	779.5			Point Of Diversion	783.8	784.5		74.4	76.2	77.2 *

(*) Based on a dischage through Outlet E (n = 0.014) of 56-, 98-, and 114-cfs for the 1%, SPF, and 1987 events, respectively.

SELECTION OF GATE CLOSURE ELEVATION

44. As indicated in paragraph 31 (page C-20), there are two selected gate closure elevations: 706.0 and 709.0. Elevation 706.0 was selected as the Minnesota River level when the gate in gatewell E should be closed, because it is the same level at which the gates in Outlets B and C of Stage 4 are to be closed, and to permit adequate time to drain the remaining runoff from the interior East Creek watershed before the closure of Outlet D. Elevation 709.0 was selected as the recommended elevation for the closure of the gate in gatewell D to again permit an adequate time period after the closure of Outlet E to empty the Outlet D pond. If the gates at Outlets D and E are operated and the portable pump(s) are installed and operated as suggested in paragraph 31, the overflow of ponded inflow from East Creek into Courthouse Lake can be avoided.

45. Periods when the level of the Minnesota River has equalled or exceeded elevations 706.0 and 709.0 at Chaska are presented in Tables C-17 and C-18, respectively. Table C-19 provides a summary of the number of years, periods, and days of blocked gravity drainage; the total rainfall which would have occurred; and ponding data with various gate closure elevations. Also presented in Tables C-17 and C-18 are the number of days that the river was above the selected elevation, the maximum river level recorded, the total recorded precipitation, the estimated runoff, and the estimated maximum interior (Outlet D) pond level which would have occurred during each period. Note in Table C-18 that during the 59 years of record there would have been only four events with a significant amount of runoff.

46. Presented in Table C-20 are the six periods with the fastest rise in the level of the Minnesota River at Chaska. Note there have been two events when the Minnesota River rose more than 5 feet during a 24-hour period and at least three additional events when the river has risen more than 2 feet in a days time. This is equivalent to two events where the river has risen a foot in 8 to 12 hours. Since the estimated time required for runoff in East Creek to travel from Outlet E to Outlet D is about six hours (see paragraph 59 (page C-39)), it is essential there be at least a two foot difference in the river level between when the gate in gatewell E is closed and when the gate in gatewell D is closed.

47. Based on the 59 years of record from October 1934 through August 1993, there would have been (as indicated in Table C-18) 28 periods of blocked gravity drainage at Outlet D, and 18 years during which a flood period would have occurred. During this same period there would have been about 382 days of blocked gravity drainage and a total of about 31.79 inches of precipitation. As indicated in Table C-18, the estimated runoff during the period would have been about 4.1 acre feet. Based on a flood period

TABLE C-17

PERIODS WHEN MINNESOTA RIVER AT CHASKA, MINNESOTA EQUALLED OR EXCEEDED ELEVATION 706.0
October 1, 1934 Through August 30, 1993
(Q = 16,000 Cfs.)

Year	Dates: From	To	Number Of Days	Minnesota River Peak Q In Cfs.	Peak Stage Hwy. 41	East Creek	Accum. Precip. In Inches	Accumulative Runoff In (Inch.) (1)	(AcFt.) (2)	Accum. Storage (AcFt.) (3)	Est. Max. Pond Level	Accum. Storage Above El. 712.0
1936	Mar 24	Mar 29	6	23200	708.4	707.5	1.62	(4)				
1943	Jun 17	Jun 26	10	25900	9.2	8.3	0.03	-				
1944	May 4	Jun 12	40	25100	9.0	8.0	8.51	3.15	234.89	237.66	>715.0	•
	Jun 15	Jun 25	11	19100	7.1	6.2	1.19	0.50	37.28	40.05	711.4	
1945	Mar 18	Mar 22	5	17700	6.6	5.7	0.00	-				
	Jun 17	Jun 22	6	18000	6.7	5.8	0.51	-				
1947	Apr 19	May 10	22	20422	7.6	6.5	2.29	-				
	Jul 9	Jul 15	7	18300	6.9	5.9	0.86	-				
1948	Mar 23	Apr 3	12	21800	8.0	7.0	0.52	-				
1949	Mar 31	Apr 16	17	31600	10.7	9.8	1.03	-				
1951	Apr 9	May 11	33	62900	17.6	16.5	2.80	-				
	Jul 3	Jul 8	6	19800	7.4	6.4	0.48	-				
1952	Apr 3	May 7	35	59100	16.8	15.8	1.09	-				
1953	Jun 12	Jun 17	6	22900	8.3	7.4	0.92	0.34	25.35	28.12	710.3	
	Aug 8	Aug 9	2	16300	6.1	5.2	0.05	-				
	Aug 11	Aug 12	2	16100	6.0	5.1	0.51	-				
1957	Jun 25	Jul 6	12	40200	12.8	11.9	2.28	1.18	87.99	90.76	714.3	•
1960	Apr 4	Apr 21	18	24200	8.7	7.8	1.09	0.21	15.66	18.43	709.0	
	May 23	Jun 1	10	35100	11.6	10.7	0.84	-				
1962	Apr 2	Apr 28	27	39400	12.7	11.7	0.74	-				
	May 25	May 28	4	17100	6.4	5.5	0.56	-				
	Jul 13	Jul 15	3	16500	6.2	5.3	0.52	-				
1965	Apr 8	May 7	30	112000	22.2	21.2	4.55	-				
	May 9	May 15	7	17200	6.4	5.5	1.35	1.96	146.15	148.92	>715.0	•
	Jun 1	Jun 4	4	16600	6.2	5.3	1.40	-				
	Jun 12	Jun 13	2	16800	6.3	5.4	0.00	-				
1966	Apr 6		1	16000	6.0	5.1	0.00	-				
1967	Apr 5	Apr 12	8	19300	7.2	6.3	1.42	1.24	92.46	95.23	714.4	•
	Jun 21	Jun 24	4	17500	6.6	5.7	1.04	-				
1968	Oct 20	Nov 2	14	37200	12.1	11.2	0.19	-				
1969	Mar 28	May 12	46	84500	20.3	19.3	2.61	-				
1971	Mar 20	Apr 10	22	24100	8.7	7.8	0.15	-				
1972	Mar 21	Mar 24	4	16600	6.2	5.3	0.52	-				
	Jun 13	Jun 16	4	16800	6.3	5.4	1.17	0.62	46.23	49.00	712.3	•
1973	Mar 15	Mar 25	11	21500	7.9	7.0	0.62	-				
1975	Apr 26	May 9	14	22900	8.3	7.4	2.68	0.55	41.01	43.78	711.8	
1979	Apr 1	May 7	37	32000	10.8	9.9	1.67	-				
	May 16	May 19	4	16600	6.2	5.3	0.27	-				
	Aug 25	Sep 7	14	27200	9.6	8.6	1.97	0.94	70.09	72.86	714.1	•
1982	Mar 23	Mar 29	7	17200	6.4	5.5	0.01	-				
1983	Mar 2	Mar 25	24	30000	10.3	9.4	2.14	0.22	16.40	19.17	709.1	
	Apr 4	May 3	30	33300	11.2	10.2	3.13	-				
	May 8	May 21	14	22100	8.1	7.2	1.35	0.11	8.20	10.97	707.8	
	Jul 4	Jul 14	11	25500	9.1	8.2	1.43	0.88	65.62	68.39	713.9	•
1984	Mar 29	May 20	53	33500	11.2	10.3	4.94	0.51	38.03	40.80	711.5	
	Jun 16	Jul 12	27	44800	13.8	12.9	4.16	2.04	152.12	154.89	>715.0	•
1985	Mar 16	Apr 11	27	31900	10.8	9.9	1.74	-				
	Apr 25	May 7	13	20200	7.5	6.5	0.11	-				
1986	Mar 22	May 28	68	36600	12.0	11.0	7.59	0.42	31.32	34.09	710.9	
	Jun 23	Jul 3	11	26300	9.4	8.4	0.79	-				
	Sep 24	Oct 7	14	24400	8.9	7.8	0.54	-				
1990	Aug 1	Aug 3	3	16800	6.3	5.4	0.08	-				
1991	May 9	May 16	8	22100	8.1	7.1	0.14	-				
	Jun 6	Jul 8	33	33000	11.1	10.2	3.93	-				
1992	Mar 4	Mar 27	24	26200	9.4	8.4	1.07	-				
	Apr 26	Apr 29	4	17180	6.4	5.5	0.02	-				
	Jul 3	Jul 16	14	20600	7.8	6.9	1.11	-				
1993	Apr 2	May 28	57	43000	13.6	12.7	5.00	-				
	Jun 7	Aug 30 (5)	85	84000	20.8	19.8	18.78	3.98	296.78	299.55	>715.0	•
Totals:			962 Days 59 Periods				108.11	18.85				

(1) Obtained from Table C-3.
(2) Equal to the indicated rainfall runoff in inches, times 894.8 acres, divided by 12.
(3) The Minnesota River level at East Creek will be about 705.1 when the level at Highway 41 is 706.0. The accumulated storage at elevation 705.1 is about 2.77 acre feet.
(4) Runoff can not be determined, because hourly rainfall is not available.
(5) On August 30, the river had receeded to only 707.89 feet.

TABLE C-18

PERIODS WHEN MINNESOTA RIVER AT CHASKA, MINNESOTA EQUALLED OR EXCEEDED ELEVATION 709.0
October 1, 1934 Through August 30, 1993
(Q = 25,400 Cfs.)

Year	Dates: From	To	Number Of Days	Minnesota River Peak Q In Cfs.	Peak Stage Hwy. 41	East Creek	Accum. Precip. In Inches	Accumulative Runoff In (Inch.) (1)	(AcFt.) (2)	Accum. Stor. (AcFt.) (3)	Est. Max. Pond Level	Accum. Storage Above El. 712.0
1943	Jun 20	Jun 21	2	25900	9.2	8.3	0.00	-				
1949	Apr 3	Apr 7	5	31600	10.7	9.8	0.00	-				
1951	Apr 9	Apr 26	18	62900	17.6	16.5	1.24	-				
1952	Apr 4	Apr 29	26	59100	16.8	15.8	0.65	-				
1957	Jun 25	Jul 1	7	40200	12.8	11.9	0.45	-				
1960	May 24	May 29	6	35100	11.6	10.7	0.82	-				
1962	Apr 3	Apr 13	11	39400	12.7	11.7	0.34	-				
1965	Apr 9	Apr 29	21	112000	22.2	21.2	2.40	-				
1968	Oct 22	Oct 28	7	37200	12.1	11.2	0.19	-				
1969	Apr 6	Apr 28	23	84500	20.3	19.3	1.35	-				
1979	Apr 3	Apr 11	9	32000	10.8	9.9	0.00	-				
	Aug 30	Sep 2	4	27200	9.6	8.6	0.18	-				
1983	Mar 5	Mar 14	10	30000	10.3	9.4	0.78	0.22	16.40	28.14	710.3	
	Apr 8	Apr 25	18	33300	11.2	10.2	1.61	-				
	Jul 8		1	25500	9.1	8.2	0.00	-				
1984	Apr 1	Apr 23	23	33500	11.2	10.3	0.97	-				
	May 8	May 10	3	26100	9.3	8.3	0.03	-				
	Jun 19	Jul 4	16	44800	13.8	12.9	1.12	-				
1985	Mar 18	Mar 23	6	31900	10.8	9.9	0.00	-				
1986	Mar 24	Apr 25	33	36000	11.8	10.8	3.57	0.32	23.86	35.60	711.0	
	Apr 28	May 9	12	36600	12.0	11.0	1.80	0.09	6.71	18.45	709.0	
	Jun 26	Jun 27	2	26300	9.4	8.4	0.02	-				
1991	Jun 8	Jun 17	10	33000	11.1	10.2	1.13	-				
1992	Mar 6	Mar 14	9	26200	9.4	8.4	0.99	-				
1993	Apr 3	Apr 30	28	42000	13.4	12.5	1.31	-				
	May 12	May 23	12	43000	13.6	12.7	0.27	-				
	Jun 18	Aug 7	51	84000	20.8	19.8	9.8	2.53	188.65	200.39	>715.0	*
	Aug 19	Aug 27	9	12.64	12.6	11.7	0.77	-				
	Totals:		382 Days 28 Periods				31.79	4.10				

(1) Obtained from Table C-3.
(2) Equal to the indicated rainfall runoff in inches, times 894.8 acres, divided by 12.
(3) The Minnesota River level at East Creek will be about 708.0 when the level at Highway 41 is 709.0. The accumulated storage at elevation 708.0 is about 11.74 acre feet.

TABLE C-19

COMPARISON OF HISTORICAL RIVER, RAINFALL AND STORAGE DATA
FOR VARIOUS GATE CLOSURE LEVELS
October 1, 1934 Through August 30, 1993

Proposed Gate Closure Elevation At Highway 41	706	707	708	709	710	711	712	713
Number Of Years With Closures	32	27	24	18	16	13	9	6
Number Of Periods	59	44	40	28	24	19	12	8
Number Of Days	* 962	* 767	565	382	271	171	119	85
Maximum Duration In Days	* 85	* 84	58	51	37	35	31	27
Total Rainfall During Periods	108.11	71.00	50.98	31.79	20.33	18.38	12.31	9.94
Number Of Events Pond Level Exceeded:								
Elevation 715.0	4	1	1	1	1	1	1	0
714.0	7	3	2	2	1	1	1	0
713.0	8	3	3	2	1	1	1	0
712.0	9	3	2	2	1	1	1	0

(*) On August 30, 1993 the river had receeded to only 707.89 feet.

TABLE C-20

RATE OF RISE IN LEVEL OF MINNESOTA RIVER AT CHASKA, MINNESOTA
DURING SIX HISTORICAL EVENTS WITH THE FASTEST RATE OF RISE

Year	Date Of Day One	Day 1		Day 2		Day 3		Day 4
1951	April 8							
	Q	13,500		30,000		58,200		
	Stage	705.0		710.3		716.6		
	Rise/Day		5.3		6.3			
1957	June 24							
	Q	13,400		31,800		40,200		
	Stage	704.9		710.8		712.9		
	Rise/Day		5.9		2.1			
1965	April 7							
	Q	8,900		19,000		43,500		94,000
	Stage	-		707.1		713.6		722.5
	Rise/Day		-		6.5		8.9	
1952	April 2							
	Q	15,100		23,200		32,800		36,600
	Stage	705.6		708.4		711.0		712.0
	Rise/Day		2.8		2.6		1.0	
1962	April 1							
	Q	12,500		17,300		29,900		38,800
	Stage	704.4		706.5		710.3		712.6
	Rise/Day		2.1		3.8		2.3	
1960	May 22							
	Q	14,600		19,800		29,200		34,900
	Stage	705.4		707.4		710.1		711.6
	Rise/Day		2.0		2.7		1.5	

during 18 of the 59 years of record, the average frequency of interior flooding is about once every 3.3 years. The duration of flooding is about 382 days during 28 events, or about 13.6 days per event. At elevation 706.0, the flow in the Minnesota River is about 16,000 cfs, which is equalled or exceeded about 4.0 percent of the time. At elevation 709.0, the flow in the Minnesota River is about 25,400 cfs, which is equalled or exceeded about 1.5 percent of the time.

DESIGN CRITERIA

DESIGN OF GRAVITY DESIGN FEATURES

48. Elevation-head-discharge curves for proposed outlet D, existing outlet from Courthouse Lake into East Creek, and the existing stormsewer connecting the Old Clay Hole with East Creek are presented on Plates C-16, C-17, and C-18, respectively. Elevation-discharge curves for proposed Outlet E, and overflow from East Creek into the proposed Diversion Channel are presented on Plate C-19. Elevation-discharge curves for overflow from East Creek into Courthouse Lake and from the Old Clay Hole into East Creek are presented on Plates C-17 and C-18, respectively.

49. The design of the two storm sewers and gravity outlets is based on criteria presented in TM 5-820-4. The design of the proposed intercepting sewer extension is based on the allowable head between the outlet invert elevation at Outlet C and the estimated existing SPS interior pond level of 712.5 for Section 3 of the Stage 4 construction. All of the proposed gravity outlets and interceptor sewers are to be constructed of reinforced concrete pipe. The Manning's roughness coefficient for concrete and corrugated metal pipe is assumed to be 0.014 and 0.024, respectively; and the entrance loss coefficient is assumed to be 0.5 for the gravity outlets and beginning point of stormsewers, and 0.2 at interior stormsewer manholes. The intercepting stormsewer extension is designed with matching crowns and a constant slope of 0.002 feet/foot. Overflow from East Creek into Courthouse Lake was obtained using the following weir equation obtained from the reference presented in paragraph 61Z (page C-41):

$$Q = 2.66 * L * H^{1.6}$$

where L is the weir length in feet and H is the equivalent head in feet for a rectangular section. The cross-section of the weir is assumed to be a triangular cross-section with a low point at elevation of 715.0 and one on 250 feet side slopes. The elevation-discharge curve for overflow from East Creek into the diversion channel was obtained from Plate B-2 of Appendix B.

50. The elevation-discharge curves for proposed outlets D and E were developed using tailwater rating curves for East Creek downstream from each respective outlet. The tailwater rating

curves, shown on Plates C-16 and C-19 were obtained by backwater analysis using computer program HEC-2. The tailwater rating curve for East Creek downstream of proposed Outlet D (station 14+00 as shown on Plate C-16) was obtained based on constant discharge runs of 27, 100, 200, 300, 400, 500, 600, and 700 cfs, assuming critical depth at the Minnesota River, and using cross-sections at 200-foot intervals obtained from a USGS quad sheet. In developing the HEC-2 model for East Creek downstream of proposed Outlet D, Manning's "n" was assumed to be 0.04 in the channel and 0.08 in the overbank areas. Also at cross-sections 800, 1200 and 1400 feet upstream from the Minnesota River, it was assumed the effective flow area is limited to a flare angle of 1:2 from Outlet D.

DEVELOPMENT OF EAST CREEK WATER SURFACE PROFILES

51. Water surface profiles for the 1-percent and Standard Project Flood theoretical events and the July 1987 historical event on East Creek for both existing and proposed conditions are presented on Plate C-10 and in Table C-16 (pages C-27 and C-28). These profiles were developed using the HEC-2 computer model based on the Manning "n" values, coefficients of enlargement and contraction, and limits of encroachment presented in Table C-21. The profiles presented on Plate C-10 and in Table C-16 were obtained using the discharge rates from the hydrographs presented in Table C-9 (page C-15) for the time period which will result in the maximum water surface level along the East Creek channel. The HEC-2 model was calibrated to high water marks obtained from the July 1987 event. The new discharge rates were then used to compute the 1-percent chance and SPS residual flood profiles. The East Creek water surface profiles for existing conditions were obtained assuming a 10-percent event occurs simultaneously on the Minnesota River. It is also assumed the frequency of event on East Creek upstream of proposed Outlet E is the same as the frequency of the event occurring within the protected area.

52. The tailwater rating curve for East Creek downstream of proposed outlet E (Station 126.5) was obtained based on HEC-2 computer runs using constant discharge rates at 20-cfs intervals between 20- and 240-cfs in East Creek from proposed Outlet D (Station 20.9) upstream and assuming a starting elevation based on the elevation-discharge curve developed for Outlet D as presented on Plate C-16.

RIPRAP AND SCOUR HOLE DESIGN

53. The design of the riprap cover required over and adjacent to the preformed scour holes and adjacent to the gravity outlets is based on standard project storm conditions and criteria presented in Hydraulic Design Criteria (HDC), sheet 712-1, ETL 1110-2-120 and computer program H7220. The assumed outlet pipe diameter, tailwater depth, and design discharge rate at Outlet D and at Outlet E are presented in Table C-22. The required minimum

TABLE C-21

SUMMARY OF EAST CREEK CHANNEL INPUT TO HEC-2 COMPUTER PROGRAM

Location (Station)	"NC" Card: Left Overbank	Right Overbank	Channel	Coefficients: Contraction	Expansion	"SB" Cards: Coefficients: Yarnell's Pier Shape	Orfice Flow Loss	Weir Discharg	Bottom Brdge. Open. (Feet)	Obst. Width (Feet)	Net Bridge Opening Below Low Chord	Side-slope	Channel Invert Elevation: Upst.	Dwnst.
20.90	0.150	0.150	0.060	0.1	0.3									
37.75						1.05	2.00	2.4	35		275		710.77	710.56
43.70	0.100	0.100	0.050	0.3	0.5									
50.65	0.100	0.100	0.050	0.3	0.5	1.05	2.00	2.6	37		255			
52.00	0.100	0.100	0.050	0.2	0.4	1.05	1.56	2.4	31		197			
52.25	0.125	0.125	0.060	0.1	0.3									
69.00				0.4	0.6									
80.00				0.2	0.4									
83.50	0.125	0.125	0.060	0.2	0.4	1.05	2.50	1.8	25		100		740.00	740.00
84.10	0.125	0.125	0.060	0.1	0.3									
84.50	0.150	0.150	0.080	0.1	0.3									
105.00	0.100	0.100	0.070	0.1	0.3									
114.00						1.05	2.05	2.2	10		100		759.6	759.00
116.00	0.080	0.080	0.050	0.1	0.3									
119.50				0.1	0.2									
121.35				0.2	0.4									
122.85						1.05	1.56	2.5	19	0.5	384	1:1	766.30	766.30
123.25				0.1	0.3									
126.50				0.2	0.4									
128.00							1.60	2.4	18		171		771.40	771.40
128.25				0.1	0.3									

Location (Station)	"X2" Card: Special Bridge Method Used	Max. Low Chord Elev.	Min. Top Of Roadway Elev.	Repeat Previous BT Card	"X3" Card - Encroachments: Total Cross-section Area	Left Encroach. Dist.	Elev.	Right Encroach. Dist.	Elev.	"ET" Card - Encroachment Limits: Run 1 Left Overbank	Right Overbank	Run 2 Left Overbank	Right Overbank	Run 3 Left Overbank	Right Overbank	Limits:
20.90								5250								
27.70								5155								
32.00								5100								
37.75					10											
38.10	1	718.00	720.20		10											
41.04				1												
47.80				1												
50.65					10											
50.75	1	726.30	728.00		10											
52.00					10											
52.25	1	726.00	726.50		10											
83.50					10			5049	745.90							
84.10	1	744.00	744.60		10											
90.00																0 9.1 9.1 9.1
93.00										4350	5830	4300	5830	4250	5830	0 5.1 7.1 9.1
96.00										4550	5780	4300	5780	4250	5780	0 5.1 7.1 9.1
99.00										4550	5600	4350	5600	4200	5600	0 5.1 7.1 9.1
102.00										4600	5500	4450	5500	4100	5500	0 5.1 7.1 9.1
105.00										4700	5600	4500	5600	4000	5600	0 5.1 7.1 9.1
108.00										4800	5600	4550	5600	4000	5600	0 5.1 7.1 9.1
111.00										4800	5250	4550	5300	4250	5300	0 5.1 7.1 9.1
114.00										4750	5250	4640	5300	4500	5300	0 5.1 7.1 9.1
116.00	1	769.70	773.10													
119.50						4650	775.00									
123.25	1	778.80	776.10													
128.25	1	780.90	780.90													
129.30						5000	783.50	5065	783.90							

allowable 50-percent stone diameters and weights for the two outlets are also indicated in Table C-22. The scour holes required at the downstream end of Outlets D and E were designed based on the criteria presented in Miscellaneous Paper H-72-5 and using a depth equal to one-half of the pipe diameter.

SELECTION OF GATE CLOSURE ELEVATIONS

54. A period of record analysis was performed based on the 59 years of record from 1 October 1934 through 30 August 1993; and a selected gate closure level of 706.0 for Outlet E and 709.0 for Outlet D.

55. The need for a ponding area during the 59 year period of record based on the selected gate closure levels is summarized in Tables C-17 (page C-30), C-18 (page C-31), and C-23 (page C-38). The periods of blocked gravity drainage indicated in Tables C-17 and C-18 include all periods from 1934 through 1993 during which the Minnesota River stage at the Highway 41 bridge equalled or exceeded the indicated proposed gate closure elevation. The maximum river stages indicated are the maximum stages recorded during each period of blocked gravity drainage. The precipitation indicated is the sum of all rainfall and/or snowmelt which occurred during the selected period based on the recorded daily amounts at Chaska. The estimated runoff was determined by obtaining all rainfall events which occurred with a Minnesota River stage above the selected gate closure elevation and determining the hourly amount of rainfall excess assuming a loss rate of 0.5 inch the first hour and 0.05 inch during each additional hour. Periods which occurred with a Minnesota River stage equal to or higher than 706.0 and would have accumulated rainfall excess are presented in Table C-3. The maximum pond elevations indicated in Tables C-17 and C-18 were then obtained by multiplying the accumulated rainfall excess from Table C-3 by 894.8 acres of watershed and divided by 12 to obtain the required volume of inflow; then adding this value to the initial storage volume to obtain the total storage required; and then obtaining the equivalent pond level from Plate C-3. The gates on the gravity outlets are assumed to remain closed throughout the flood period.

56. Because of the long duration of high river levels and large amounts of precipitation during the 1993 flood, this analysis was further refined as indicated in Table C-23 and the size of a portable pumping facility determined. The size of portable pump required (adjacent to Outlet D) was determined by preparing a detailed study of runoff during the nine historical flood events presented in Table C-17, which without pumping would result in a maximum pond level higher than 712.0. The estimated hourly inflow occurring during these nine periods was obtained from Table C-3. Inflow hydrographs to Pond D for 13 of the Table C-3 events were obtained using computer program HEC-1 and are presented in Table C-11. The estimated storage required for various pumping rates was

TABLE C-22

DETERMINATION OF REQUIRED RIPRAP SIZE DOWNSTREAM OF OUTLETS D AND E

Determination of Required Variables:

	Q	TW	TW Height Above Invert	Area (1)	Ave. Velocity At Pipe	At Apron	
Outlet E:							
D=48							
A=12.57	0	769.75					
Inv 770.0	20	770.83	0.83	5.25	1.59	3.81	
2-Hr. Dur.	40	771.40	1.40	8.86	3.18	4.51	
	60	771.82	1.82	11.52	4.77	5.21	
	80	772.17	2.17	13.74	6.36	5.82	
Apron (4):	100	772.44	2.44	15.45	7.96	6.47	
L=6.00'	120	772.69	2.69	17.03	9.55	7.05	
W=7.0'	140	772.90	2.90	18.36	11.14	7.63	
We=D+2L/6	160	773.09	3.09	19.56	12.73	8.18	
=6.33	180	773.27	3.27	20.70	14.32	8.70	
	200	773.43	3.43	21.71	15.91	9.21	
	220	773.58	3.58	22.66	17.50	9.71	*
	240	773.73	3.73	23.61	19.09	10.16	
Outlet D:							
D=84	0	700.60	1.60	24.53	0.00	0.00	
A=38.48	100	702.55	3.55	54.42	2.60	1.84	
Inv. 699.0	200	703.18	4.18	64.08	5.20	3.12	
1-Hr. Dur.	300	703.49	4.49	68.83	7.80	4.36	
	400	703.71	4.71	72.20	10.40	5.54	
Apron (4):	500	703.91	4.91	75.27	12.99	6.64	
L=25.0'	600	704.08	5.08	77.88	15.59	7.70	
W=19.83'	700	704.23	5.23	80.18	18.19	8.73	*
We=D+2L/6							
=15.33							

Outlet Location:	D	E
Q:	697	220
D:	84	48
D50: (2)	20.86	13.93
0.62*D50:	12.93	8.64
W50:	108	32

Required Gradiations: (Based on a specic weight of 165 lbs/cu.ft.)

Based On ETL 1110-2-120 (Incl. 3): (Minimum Allowable Graduation)

Thickness In Inches	27		18		12	
% Lighter By Weight						
100	292	117	86	35	26	10
50	123	58	36	17	11	5
15	62	18	18	5	5	2

(*) Design condition.

(1) Area is equal to the height of the tailwater above the pipe invert elevation times an effective width of 4.75' for outlet E and 15.33 for outlet D.

(2) D50^3 = (6*W50)/(3.1416*165)
(D50 was obtained using computer program H7220.)

(3) Obtained from EM 1601 (1991 version).

(4) Given length and width of concrete apron upstream of scour hole.

TABLE C-23

DETERMINATION OF REQUIRED SIZE OF PORTABLE PUMPING STATION
Based On Periods Indicated In Table C-16 With
An Estimated Maximum Pond Level Of 713.0 Or Higher

Selected Gate Closure Elevation	Year	Dates: From	To	Peak Stream-flow (Cfs)	Date Of Periods With Runoff (1)	Runoff: In Inches	In AcFt. (2)	No Pumping Accum. Storage	Maximum AcFt.	Pond Levels (3): Without Pumping Elev.	5 Cfs Elev.	10 Cfs Elev.
706	1944	May 4	Jun 12	25100								
					Jun 4 *		12.66	12.66	15.43	708.6	708.3	708.1
					Jun 5 *		82.45	95.11	97.88	>15.0	>15.0	15.0
	1957	Jun 25	Jul 6	40200	Jul 3 *		28.26	28.26	31.03	10.6	10.6	10.3
	1965	May 9	May 15	17200	May 7-8 *		54.12	54.12	56.89	12.9	omit	
	1967	Apr 5	Apr 12	19300	Apr 5 *		14.79	14.79	17.56	8.9	8.8	8.6
	1979	Aug 25	Sep 7	27200	Aug 29 *		19.55	19.55	22.32	9.6	omit	
	1983	Jul 4	Jul 14	25500	Jul 4 *		16.85	16.85	19.62	9.2	omit	
	1984	Jun 16	Jul 12	44800								
					Jun 17	0.16	11.93	11.93	14.7	8.5	8.4	8.4
					Jul 10-11 *		56.27	68.20	70.97	14.1	12.6	12.4
	1993	Jun 7	Aug 30	84000								
					Jun 16-17 *		37.82	37.82	40.59	11.5	10.8	10.3
					Jul 1 *		6.69	44.51	47.28	12.1	7.7	6.9
							29.34	73.85	76.62	14.5	11.2	10.8
					Jul 3 *		24.73	98.58	101.35	>15.0	12.4	11.0
							1.54	100.12	102.89	>15.0		
					Aug 8-9	0.21	15.66	115.78	118.55	>15.0	8.8	8.8
					Aug 18	0.67	49.96	165.74	168.51	>15.0	12.5	12.5
708	1944	May 9	May 13	24100								
	1944	May 23	May 29	25100								
	1957	Jun 25	Jul 2	40200								
	1979	Aug 29	Sep 4	27200	Aug 29 *		19.55	19.55	27.57	10.2	omit	
	1983	Jul 6	Jul 11	25500								
	1984	Jun 18	Jul 6	44800								
	1993	Jun 15	Aug 11	84000								
					Jun 16-17 *		37.82	37.82	45.84	12.0	11.3	10.8
					Jul 1 *		6.69	44.51	52.53	12.6	8.6	8.2
							29.34	73.85	81.87	14.9	11.7	11.3
					Jul 3 *		24.73	98.58	106.6	>15.0	12.9	11.5
							1.54	100.12	108.14	>15.0		
					Aug 8-9	0.21	15.66	115.78	123.8	>15.0	9.6	9.6
	1993	Aug 18	Aug 29	39000	Aug 18	0.67	49.96	165.74	173.76	>15.0	12.9	12.9
709	1957	Jun 25	Jul 1	40200								
	1979	Aug 30	Sep 2	27200								
	1983	Jul 8		25500								
	1984	Jun 19	Jul 4	44800								
	1993	Jun 18	Aug 7	84000								
					Jun 16-17 *		37.82	37.82	49.56	12.3	11.7	11.1
					Jul 1 *		6.69	44.51	56.25	12.9	9.1	8.7
							29.34	73.85	85.59	>15.0	12.1	11.7
					Jul 3 *		24.73	98.58	110.32	>15.0	13.2	11.8
							1.54	100.12	111.86	>15.0		
		Aug 19	Aug 27	39000	Aug 18	0.67	49.96	49.96	61.7	13.3	13.2	13.2

(1) Obtained from Table C-3.
(2) Assumes a contributing watershed of 894.8 acres.
* Based on inflow hydrographs prepared for event. (See Table C-11.)
(3) Initial storage values:

Selected closure elevation:	706	708	709
Elevation at Outlet D:	705.1	707	708
Initial storage in AcFt.:	2.77	8.02	11.74

then developed from each of these 13 hydrographs. Pondage during these events for which inflow hydrographs were not developed was determined by multiplying the rainfall excess values from Table C-3 times the 894.8 acres of contributing watershed, divided by 12.

57. Pond elevation-frequency curves developed for each temporary ponding area are presented on Plate C-15.

58. To select the best operating plan during periods of blocked gravity drainage, it became necessary to determine the rate of rise of flood levels along the Minnesota River and the estimated time required to drain/empty the proposed Outlet D pond prior to the closure of Gatewell D.

59. The estimated time required for flows in East Creek to travel from proposed Outlet E to proposed Outlet D was obtained by determining the travel time between the HEC-2 cross-sections for each of four events and summing the incremental travel times. The estimated travel time between sections was determined by dividing the distance between the sections by the indicated average channel velocity. The resulting estimated travel time from Outlet E to Outlet D was determined for a constant channel discharge of 20 and 100 cfs, for the theoretical 1-percent event and for the historical July 1987 event. The estimated total travel time for these events was 6.14, 3.84, 2.66, and 2.83 hours, respectively. Based on these results, it is assumed it will take up to 6 hours to drain the interior creek channel.

ALTERNATE PLANS

60. Six alternate plans were considered for providing erosion and scour protection at the downstream end of Outlets D and E. Considered were the construction of a preformed scour hole, an SAF Stilling Basin, an impact energy dissipator, deflector buckets, and a riprap blanket. The riprap blanket was eliminated because of its enormous size. The stilling basins, energy dissipator and the deflector buckets were eliminated because of their enormous size and excessive costs.

REFERENCES

61. The following references were used in the development of the interior flood control plan:

a. EM 1110-2-1411, "Standard Project Flood Determination," (Civil Works Engineer Bulletin No. 52-8, March 1952).

b. EM 1110-2-1413, "Hydrologic Analysis of Interior Areas," January 1987.

c. EM 1110-2-1601, "Hydraulic Design of Flood Control Channels."

d. EM 1110-2-1602, "Hydraulic Design of Reservoir Outlet Works."

e. ETL 1110-2-120, "Engineering And Design, Additional Guidance For Riprap Channel Protection."

f. TM 5-820-4, "Drainage for Areas Other Than Airfields."

g. Hydraulic Design Criteria, Sheet 712-1, "Stone Stability, Velocity Versus Stone Diameter," Revised 9-70.

h. "Water Resources Data for Minnesota," U.S. Department of the Interior, Geological Survey.

i. National Weather Service HYDRO-35, "Five- to 60-Minute Precipitation Frequency For The Eastern And Central United States," June 1977.

j. National Weather Service Technical Report No. 40, "Rainfall Frequency Atlas of the United States," May 1961.

k. National Weather Service Technical Report No. 49, "Two- to Ten-day Precipitation for Return Periods of 2 to 100 Years in the Contiguous United States," 1964.

l. Soil Conservation Service Technical Release No. 55, "Urban Hydrology for Small Watersheds," June 1986.

m. SCS National Engineering Handbook, Sections 4 and 6, Soil Conservation Service, U.S. Department of Agriculture, August 1972.

n. "Climatological Data," National Oceanic and Atmospheric Administration, Environmental Data Service, U. S. Department of Commerce.

o. "Minnesota River At Chaska, Minnesota, Flood Control Project, Phase I General Design Memorandum and Draft Supplement To Final Environmental Impact Statement," April 1982.

p. "Minnesota River At Chaska, Minnesota, Limited Reevaluation Report And Final Supplement To The Final Environmental Impact Statement For Flood Control And Related Purposes," August 1982.

q. "Minnesota River At Chaska, Minnesota, Flood Control Project, General Design Memorandum," Revised August 1984.

r. "Minnesota River At Chaska, Minnesota, Flood Control Project, General Design Memorandum, Supplement No. 1," April 1986.

s. "Minnesota River At Chaska, Minnesota, Flood Control Project, General Design Memorandum, Supplement No. 2," December

1989.

t. "Flood Control, Minnesota River, Minnesota, Report On Portable Maximum Floods And Standard Project Floods, Minnesota River Basin, Minnesota," January 1971.

u. "Hydraulic Charts for the Selection of Highway Culverts," Hydraulic Engineering Circular No. 5, U.S. Department of Transportation, Federal Highway Administration, April 1977.

v. "Erosion Control Measures At Storm Sewer And Culvert Outlets," by John L. Grace, Jr., Waterways Experiment Station, Vicksburg, Mississippi.

w. "Practical Guidance For Estimating And Controlling Erosion At Culvert Outlets," Miscellaneous Paper H-72-5, by B.P. Fletcher and J.L. Grace, Jr., U.S. Army Waterways Experiment Station, Vicksburg, Mississippi, May 1972.

x. Conversationally Oriented Real-Time Program Generating System (CORPS) computer program H7220: "Erosion at Culvert Outlets and Riprap Requirements," November 1988 version.

y. "Straight Drop Spillway Stilling Basin," by Charles A. Donnelly and Fred W. Blaisdell, Hydraulic Engineers, USDA, ARS, Technical Paper No. 15, Series B, University Of Minnesota St. Anthony Falls Hydraulic Laboratory, November 1954.

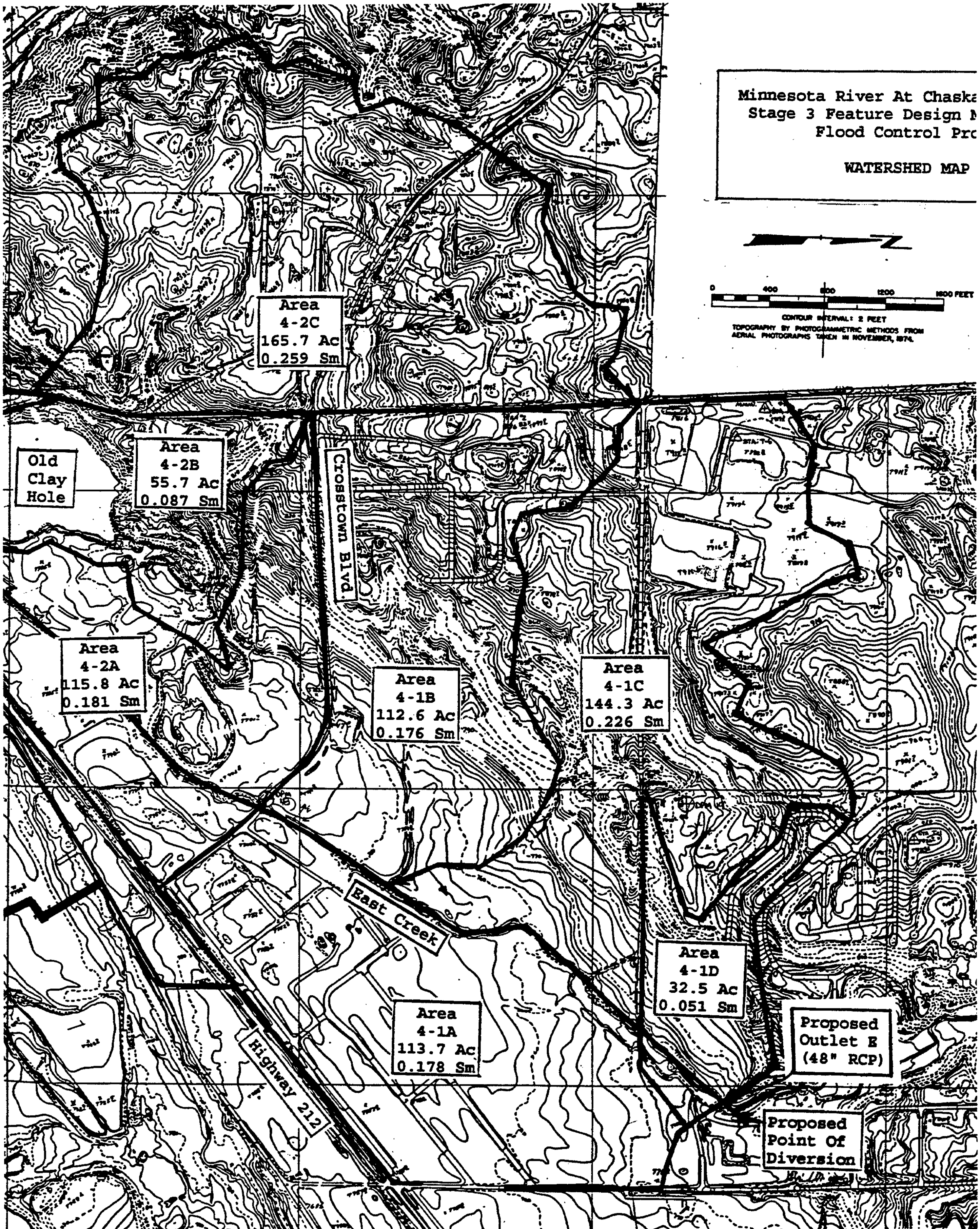
z. "Flow of Flood Water Over Railway and Highway Embankments," by David L. Yarnell and Floyd A. Nagler, published in "Public Works," April 1930.

aa. "Hydraulic Design of Stilling Basins and Energy Dissipators, " Engineering Monograph No. 25, U.S. Department of the Interior, Bureau Of Reclamation.

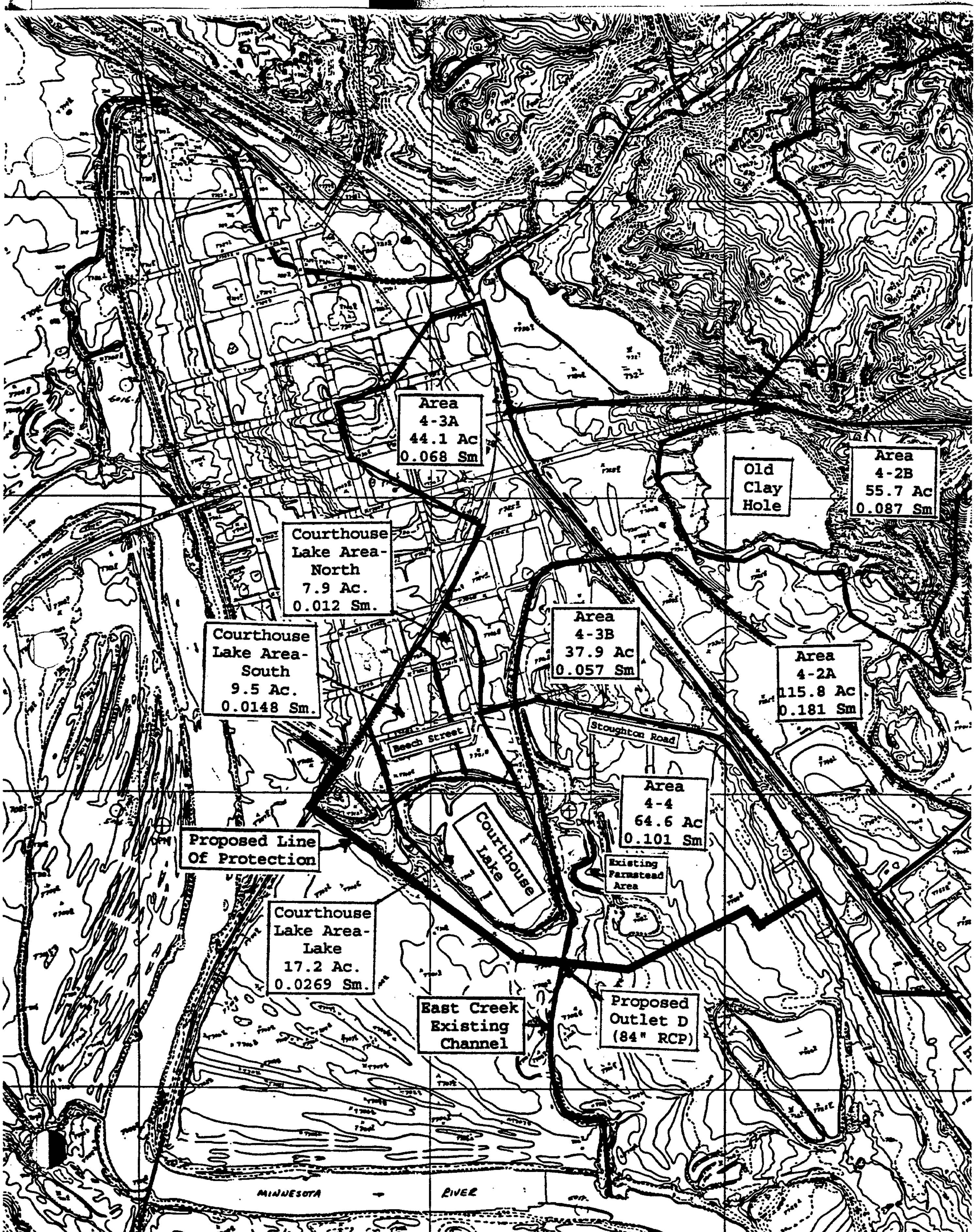
bb. "Evaluation of Flared Outlet Transitions," Hydraulic Model Investigation," Research Report H-72-1, by B.P. Fletcher and J.L. Grace, Jr., June 1972.

cc. "HEC-1 Flood Hydrograph Package, User's Manual," U.S. Army Corps Of Engineers' Hydrologic Engineering Center, Davis California, September 1990.

dd. "HEC-2 Water Surface Profiles, User's Manual," U.S. Army Corps Of Engineers' Hydrologic Engineering Center, Davis, California, September 1990.



Minnesota River At Chask
Stage 3 Feature Design
Flood Control Pro
WATERSHED MAP
0 400 800 1200 1600 FEET
CONTOUR INTERVAL: 2 FEET
TOPOGRAPHY BY PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHS TAKEN IN NOVEMBER, 1974.
Area 4-2C 165.7 Ac 0.259 Sm
Old Clay Hole
Area 4-2B 55.7 Ac 0.087 Sm
Crosstown Blvd
Area 4-2A 115.8 Ac 0.181 Sm
Area 4-1B 112.6 Ac 0.176 Sm
Area 4-1C 144.3 Ac 0.226 Sm
East Creek
Area 4-1D 32.5 Ac 0.051 Sm
Area 4-1A 113.7 Ac 0.178 Sm
Highway 212
Proposed Outlet E (48" RCP)
Proposed Point Of Diversion


Area
4-3A
44.1 Ac
0.068 Sm
Old
Clay
Hole
Area
4-2B
55.7 Ac
0.087 Sm
Courthouse
Lake Area-
North
7.9 Ac.
0.012 Sm.
Courthouse
Lake Area-
South
9.5 Ac.
0.0148 Sm.
Area
4-3B
37.9 Ac
0.057 Sm
Area
4-2A
115.8 Ac
0.181 Sm
Beech Street
Stoughton Road
Area
4-4
64.6 Ac
0.101 Sm
Courthouse
Lake
Proposed Line
Of Protection
Existing
Farmstead
Area
Courthouse
Lake Area-
Lake
17.2 Ac.
0.0269 Sm.
East Creek
Existing
Channel
Proposed
Outlet D
(84" RCP)
MINNESOTA
RIVER

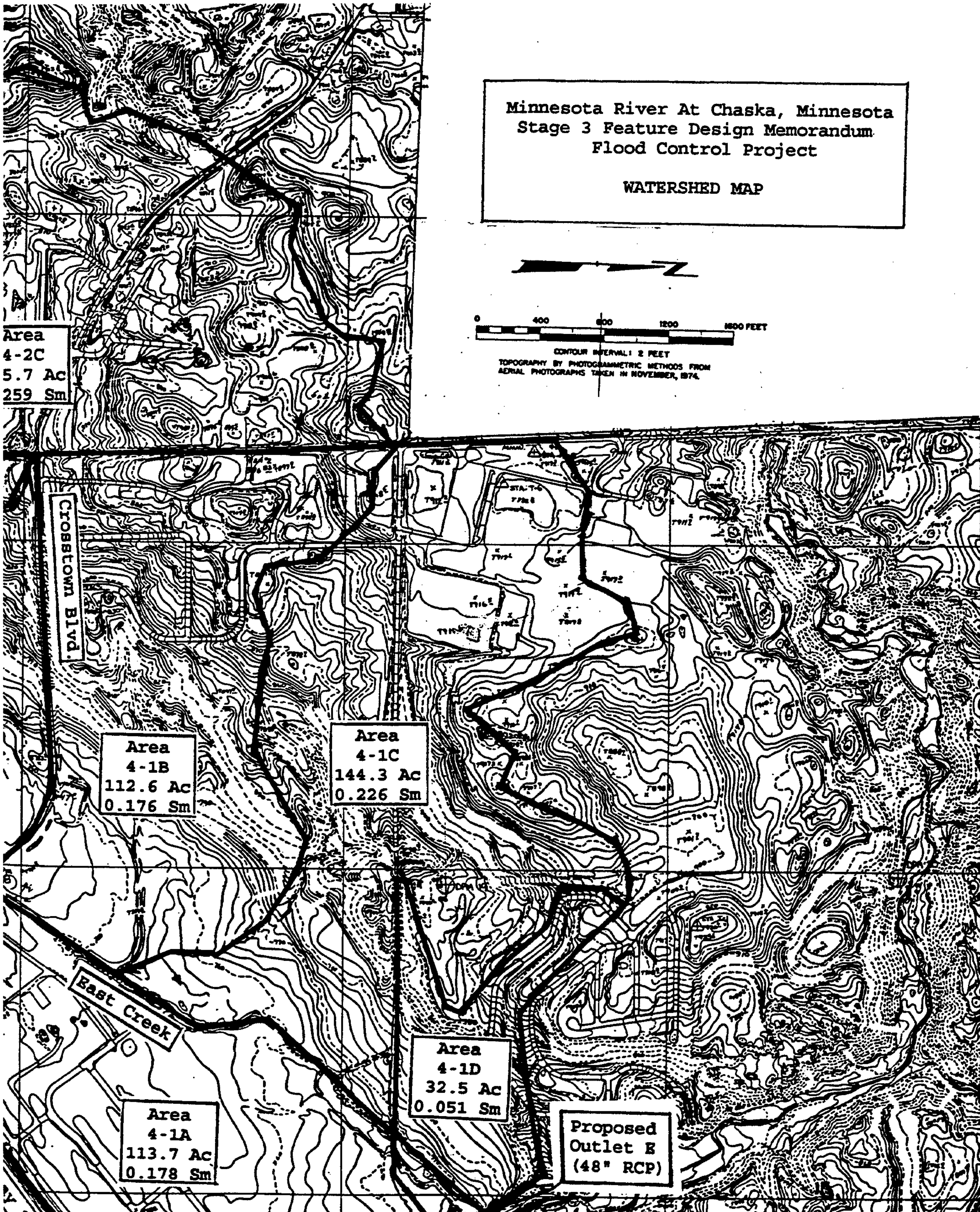
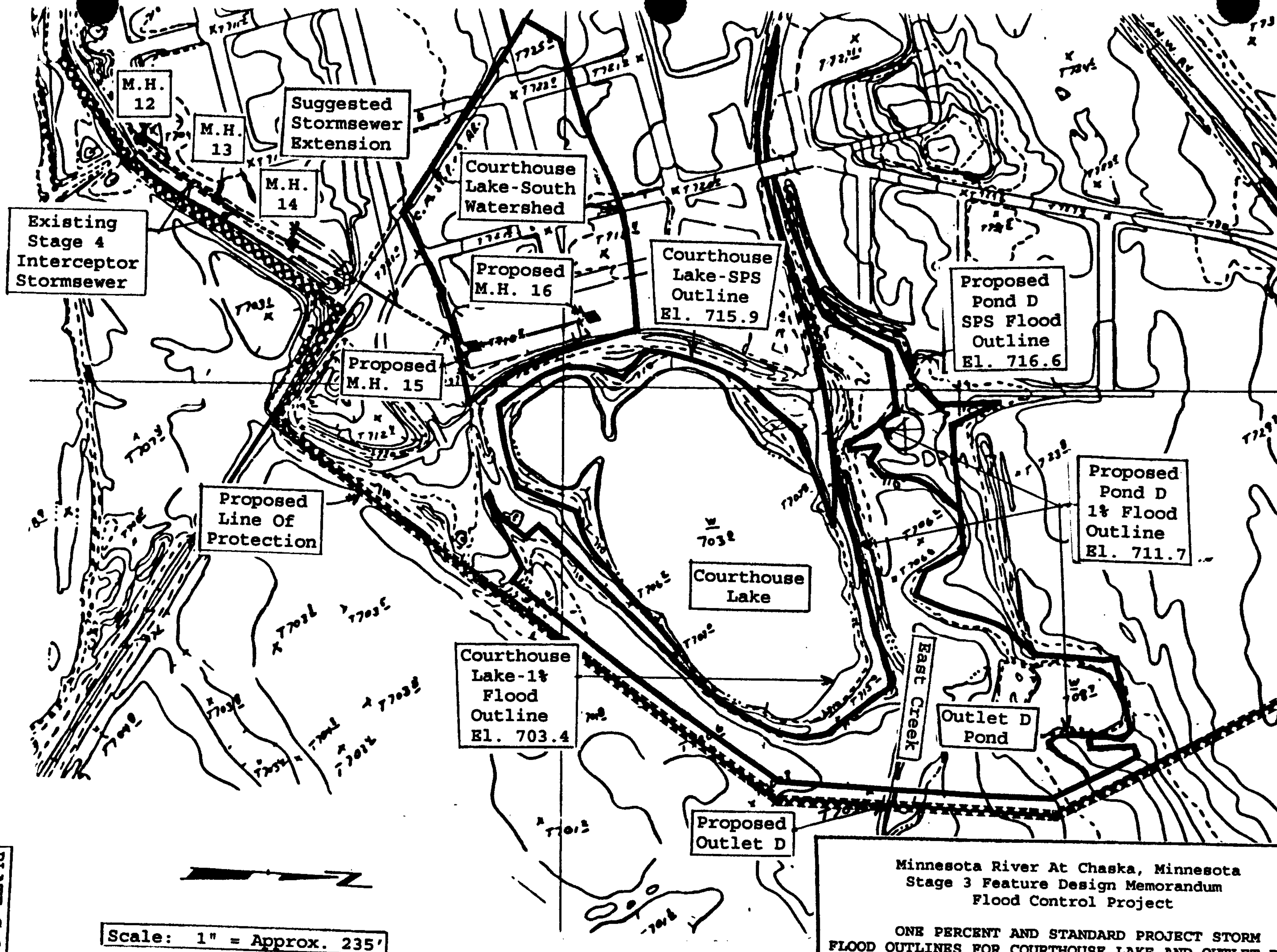

Minnesota River At Chaska, Minnesota
Stage 3 Feature Design Memorandum
Flood Control Project
WATERSHED MAP
0 400 800 1200 1600 FEET
CONTOUR INTERVAL: 2 FEET
TOPOGRAPHY BY PHOTOGRAMMETRIC METHODS FROM AERIAL PHOTOGRAPHS TAKEN IN NOVEMBER, 1974.
Area 4-2C 5.7 Ac 259 Sm
Crosstown Blvd.
Area 4-1B 112.6 Ac 0.176 Sm
Area 4-1C 144.3 Ac 0.226 Sm
East Creek
Area 4-1D 32.5 Ac 0.051 Sm
Area 4-1A 113.7 Ac 0.178 Sm
Proposed Outlet E (48" RCP)
Proposed Point Of Diversion

PLATE C-1



Minnesota River At Chaska, Minnesota
Stage 3 Feature Design Memorandum
Flood Control Project

ONE PERCENT AND STANDARD PROJECT STORM FLOOD OUTLINES FOR COURTHOUSE LAKE AND OUTLET D POND AND LOCATION OF PROPOSED STORMSEWER EXTENSION

PLATE C-2

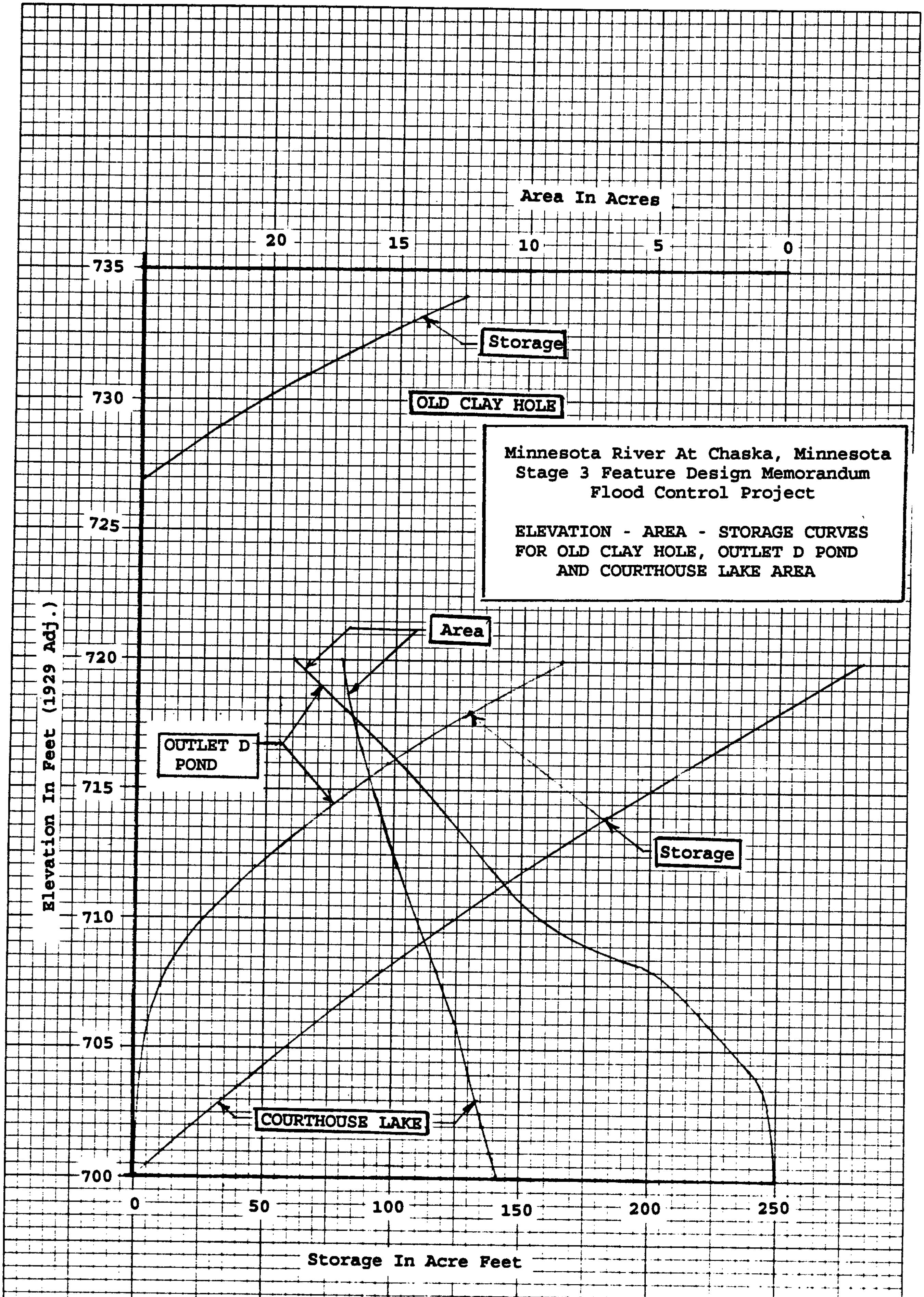
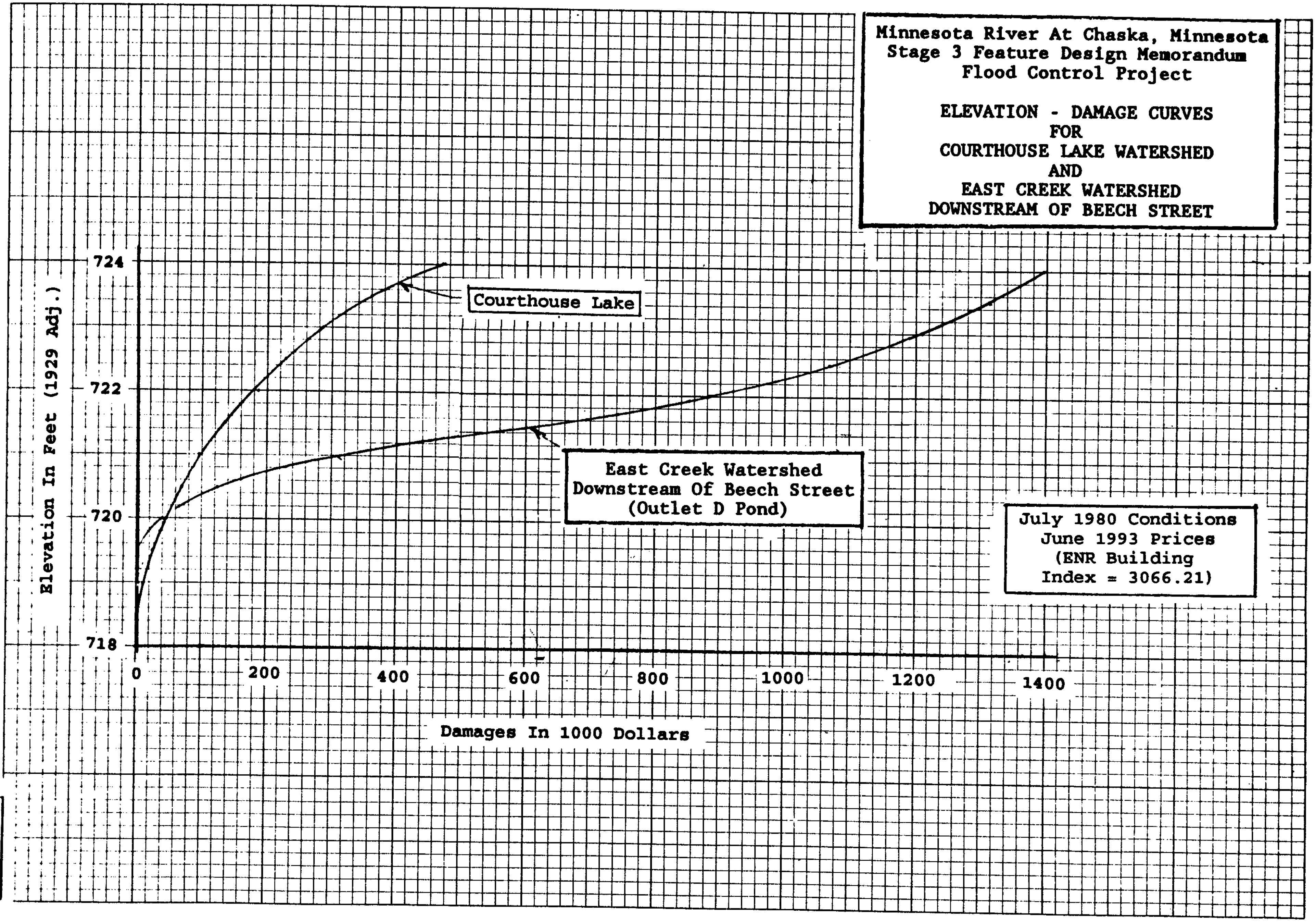
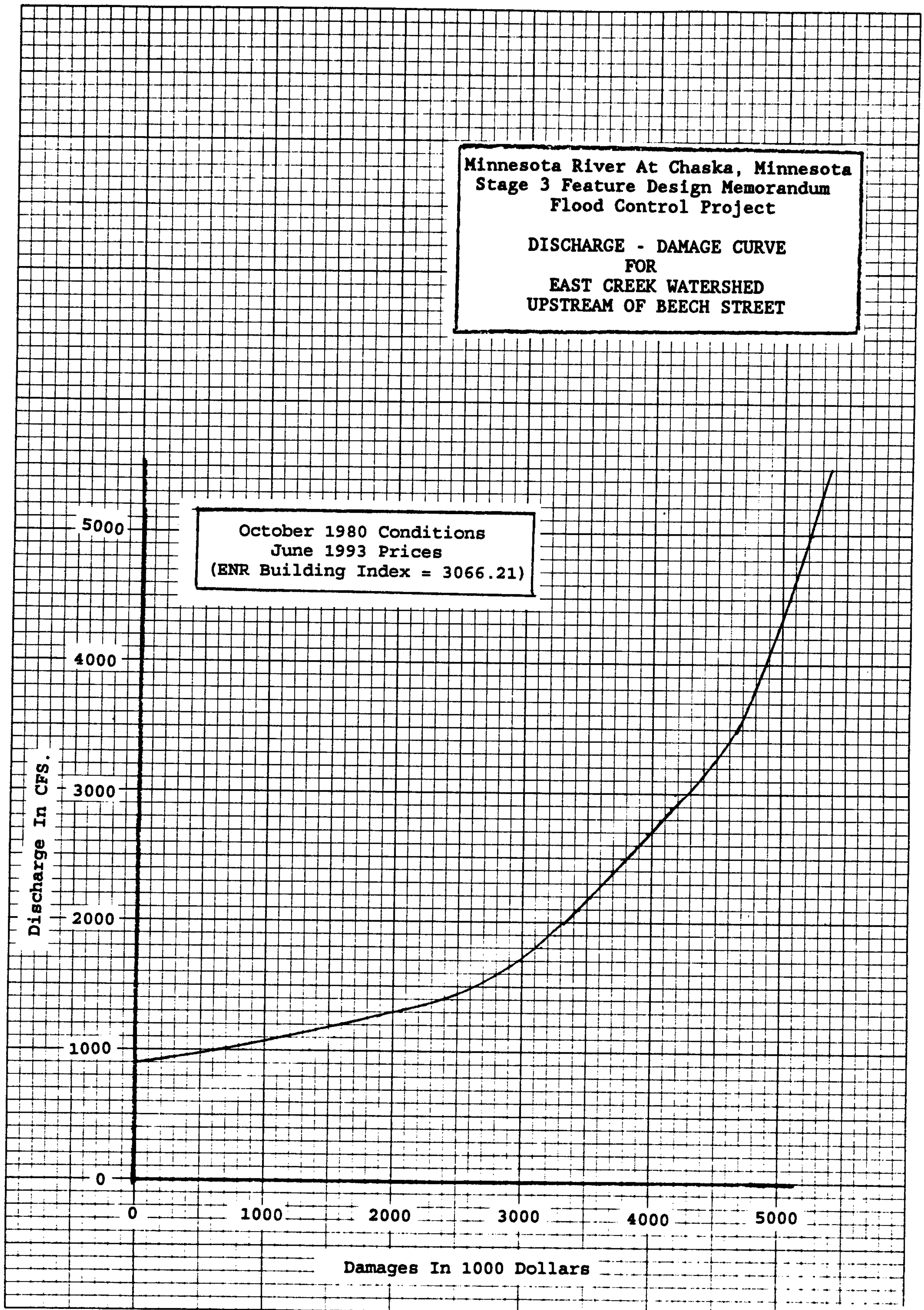

Area In Acres
20
15
10
5
0
735
730
725
720
715
710
705
700
Storage
OLD CLAY HOLE
Minnesota River At Chaska, Minnesota
Stage 3 Feature Design Memorandum
Flood Control Project
ELEVATION - AREA - STORAGE CURVES
FOR OLD CLAY HOLE, OUTLET D POND
AND COURTHOUSE LAKE AREA
Area
OUTLET D
POND
Storage
Elevation In Feet (1929 Adj.)
COURTHOUSE LAKE
0
50
100
150
200
250
Storage In Acre Feet

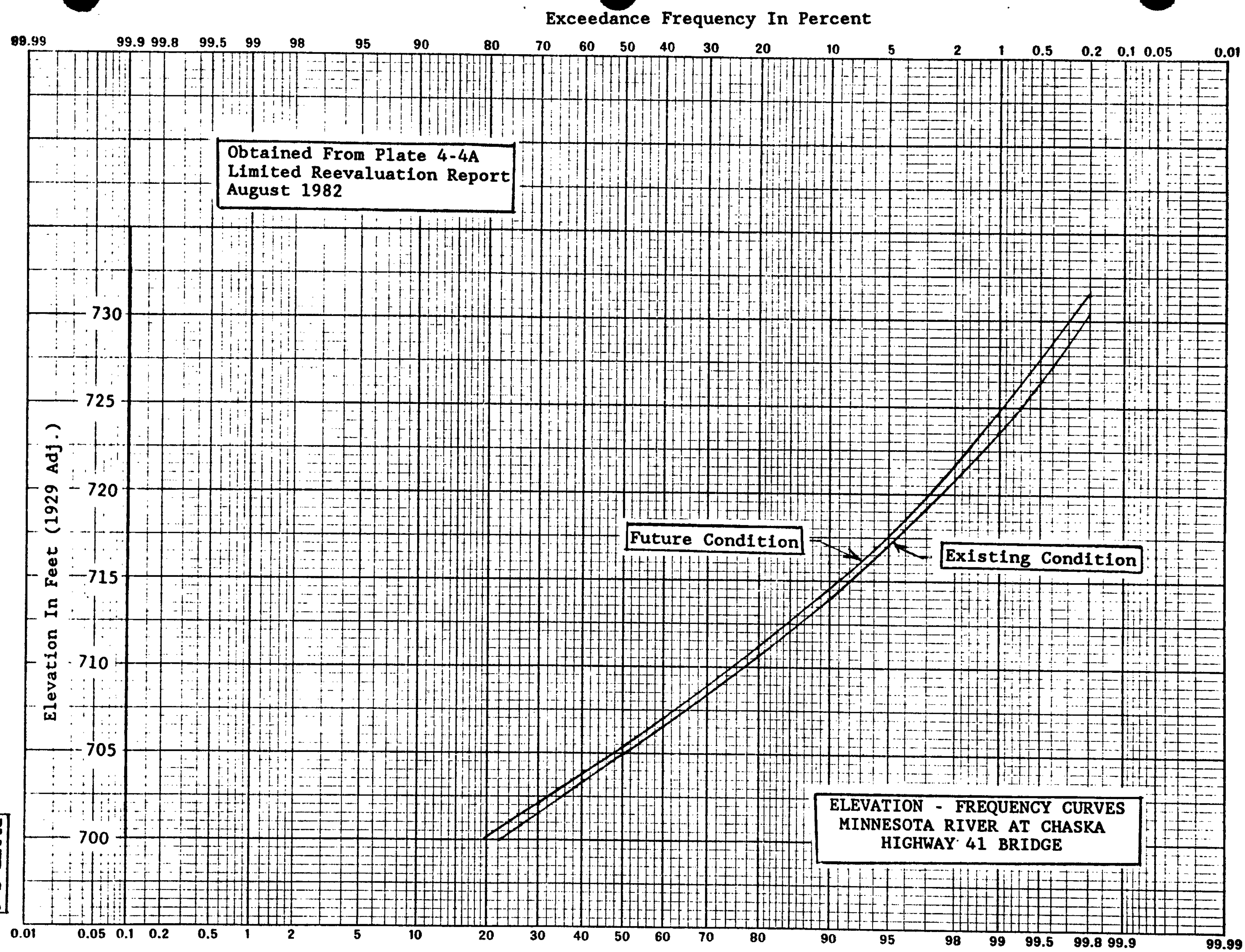
PLATE C-3

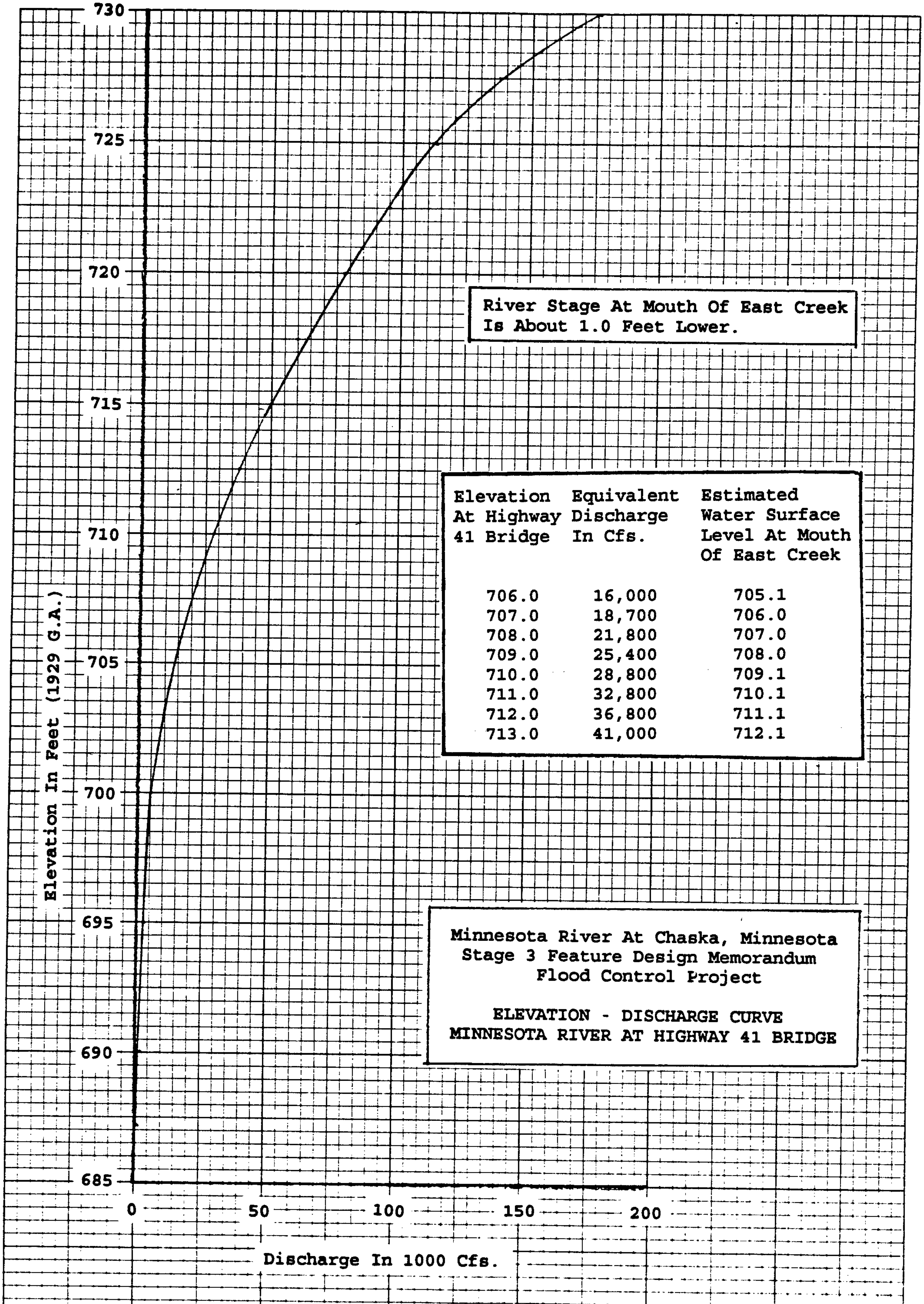

Minnesota River At Chaska, Minnesota
Stage 3 Feature Design Memorandum
Flood Control Project
ELEVATION - DAMAGE CURVES
FOR
COURTHOUSE LAKE WATERSHED
AND
EAST CREEK WATERSHED
DOWNSTREAM OF BEECH STREET
Courthouse Lake
East Creek Watershed
Downstream Of Beech Street
(Outlet D Pond)
July 1980 Conditions
June 1993 Prices
(ENR Building
Index = 3066.21)
Elevation In Feet (1929 Adj.)
724
722
720
718
0
200
400
600
800
1000
1200
1400
Damages In 1000 Dollars



Minnesota River At Chaska, Minnesota
Stage 3 Feature Design Memorandum
Flood Control Project
DISCHARGE - DAMAGE CURVE
FOR
EAST CREEK WATERSHED
UPSTREAM OF BEECH STREET
October 1980 Conditions
June 1993 Prices
(ENR Building Index = 3066.21)
Discharge In CFS.
0
1000
2000
3000
4000
5000
Damages In 1000 Dollars

PLATE C-5

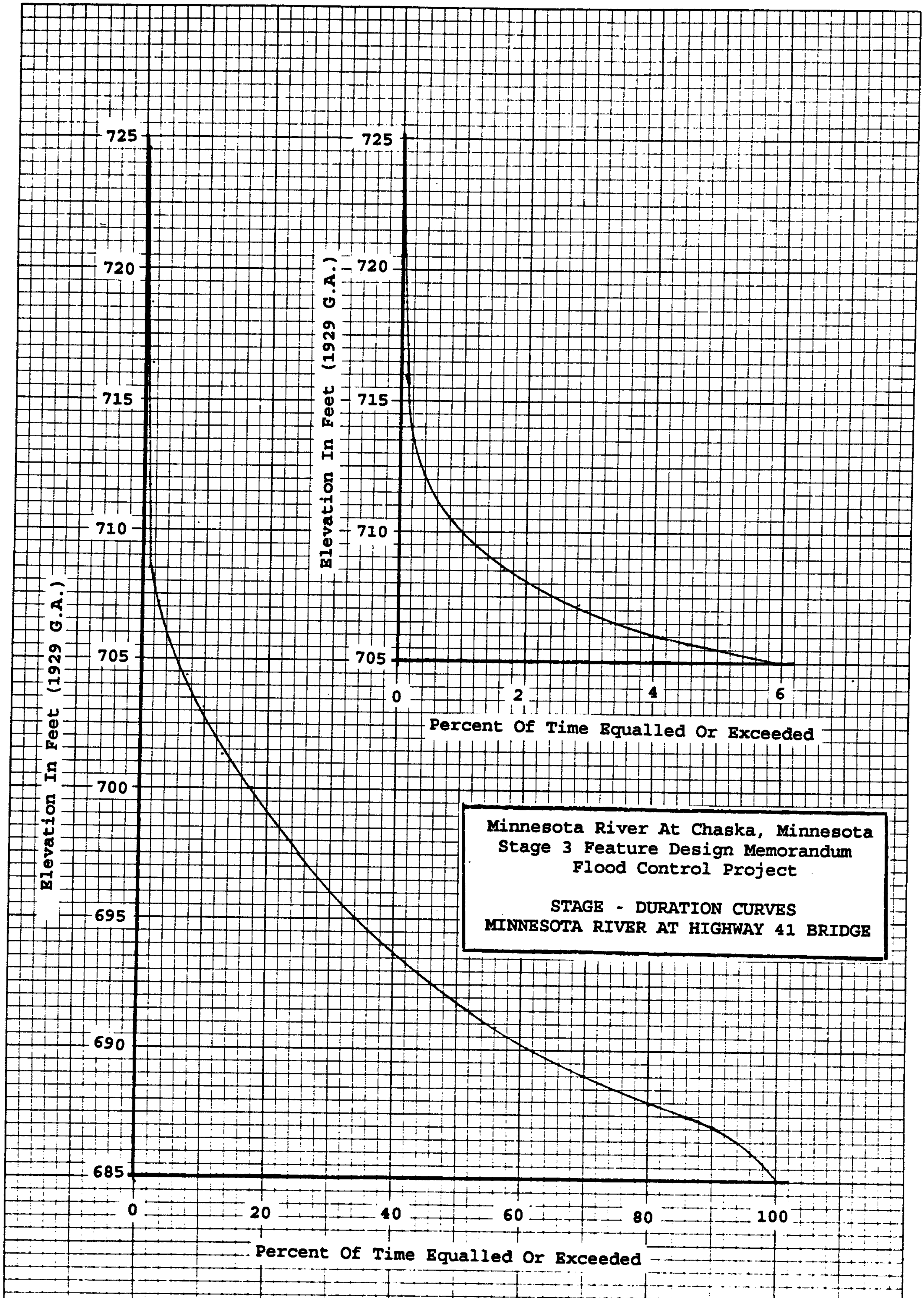

Exceedance Frequency In Percent
Elevation In Feet (1929 Adj.)
Obtained From Plate 4-4A
Limited Reevaluation Report
August 1982
Future Condition
Existing Condition
ELEVATION - FREQUENCY CURVES
MINNESOTA RIVER AT CHASKA
HIGHWAY 41 BRIDGE



Elevation At Highway 41 Bridge	Equivalent Discharge In Cfs.	Estimated Water Surface Level At Mouth Of East Creek
706.0	16,000	705.1
707.0	18,700	706.0
708.0	21,800	707.0
709.0	25,400	708.0
710.0	28,800	709.1
711.0	32,800	710.1
712.0	36,800	711.1
713.0	41,000	712.1

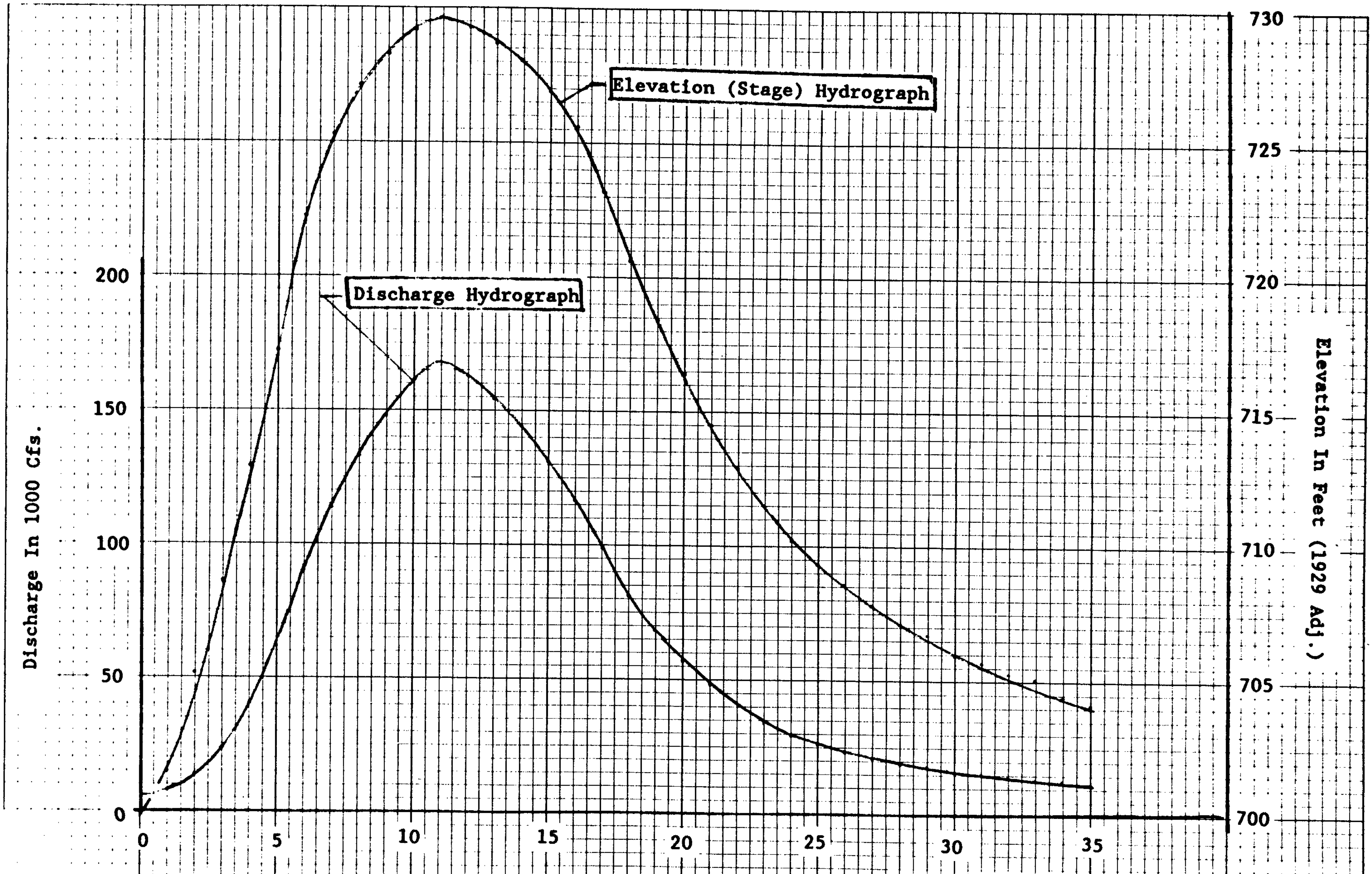
Minnesota River At Chaska, Minnesota
Stage 3 Feature Design Memorandum
Flood Control Project

ELEVATION - DISCHARGE CURVE
MINNESOTA RIVER AT HIGHWAY 41 BRIDGE



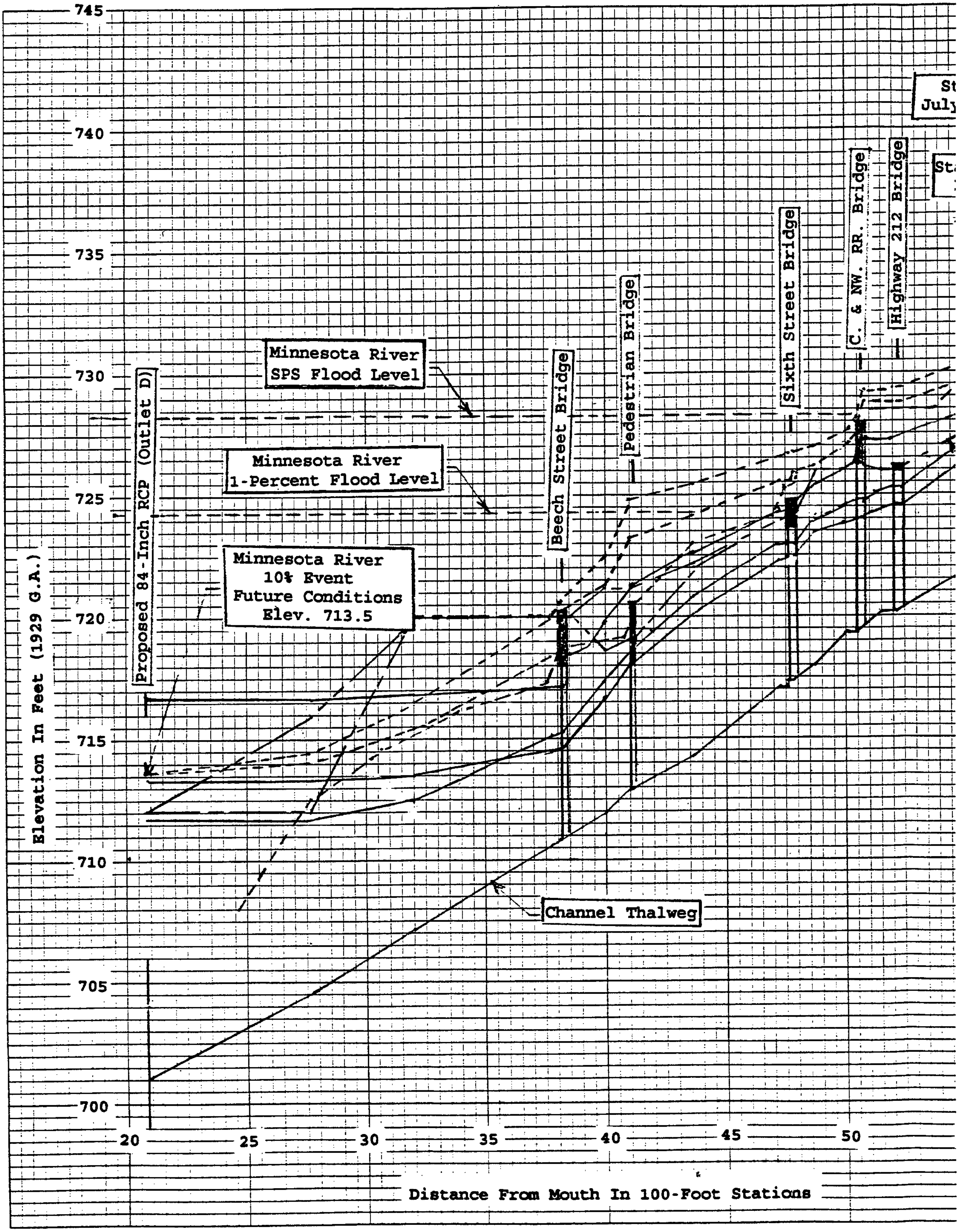
725
720
715
710
705
700
695
690
685
0
20
40
60
80
100
Elevation In Feet (1929 G.A.)
Percent Of Time Equalled Or Exceeded
725
720
715
710
705
0
2
4
6
Elevation In Feet (1929 G.A.)
Percent Of Time Equalled Or Exceeded
Minnesota River At Chaska, Minnesota
Stage 3 Feature Design Memorandum
Flood Control Project
STAGE - DURATION CURVES
MINNESOTA RIVER AT HIGHWAY 41 BRIDGE

46 0700



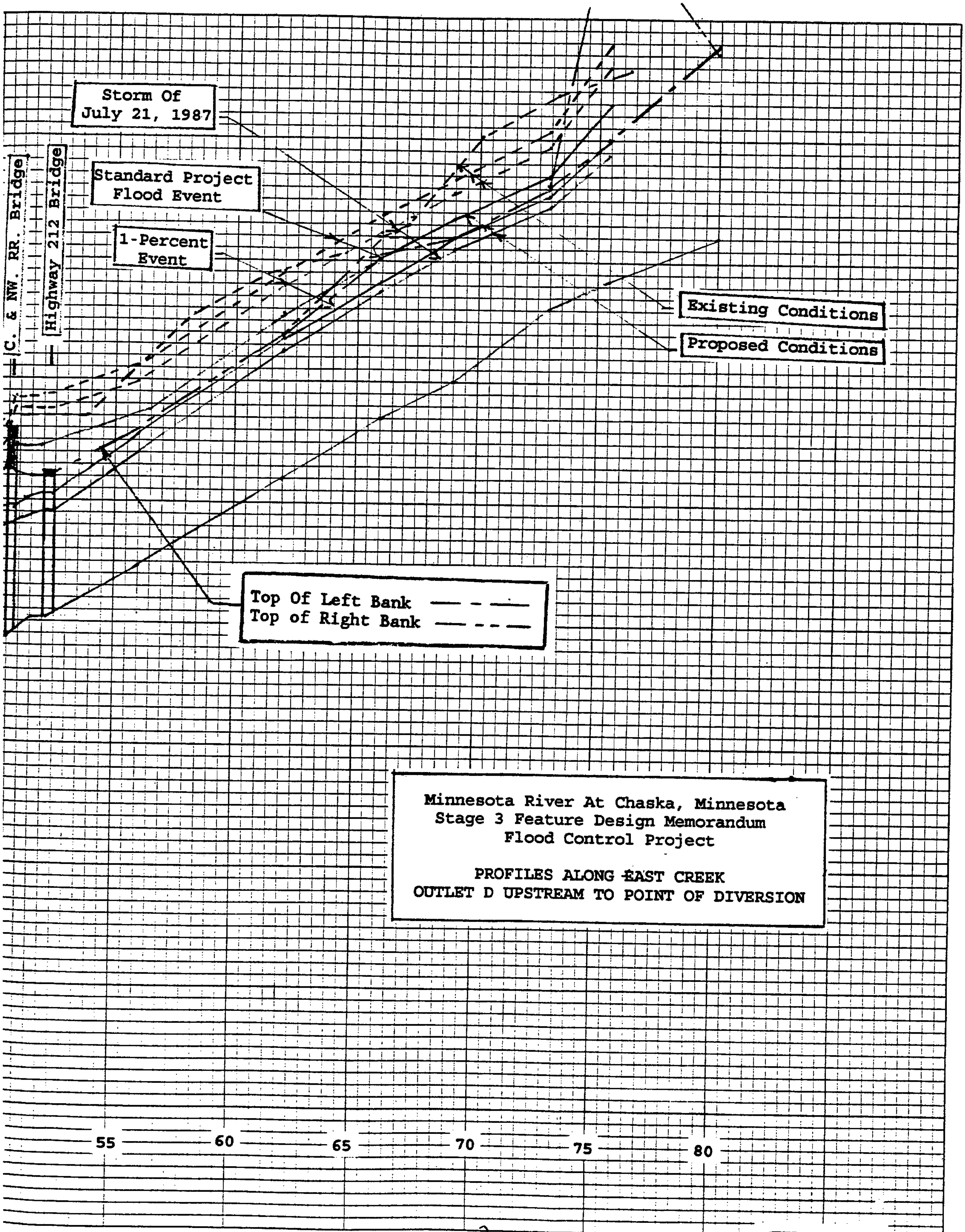
STANDARD PROJECT FLOOD
STAGE - DISCHARGE HYDROGRAPHS
MINNESOTA RIVER AT CHASKA, MINNESOTA

PLATE C-9



745
740
735
730
725
720
715
710
705
700
20
25
30
35
40
45
50
Elevation In Feet (1929 G.A.)
Distance From Mouth In 100-Foot Stations
Minnesota River
SPS Flood Level
Minnesota River
1-Percent Flood Level
Minnesota River
10% Event
Future Conditions
Elev. 713.5
Proposed 84-Inch RCP (Outlet D)
Beech Street Bridge
Pedestrian Bridge
Sixth Street Bridge
C. & NW. RR. Bridge
Highway 212 Bridge
Channel Thalweg

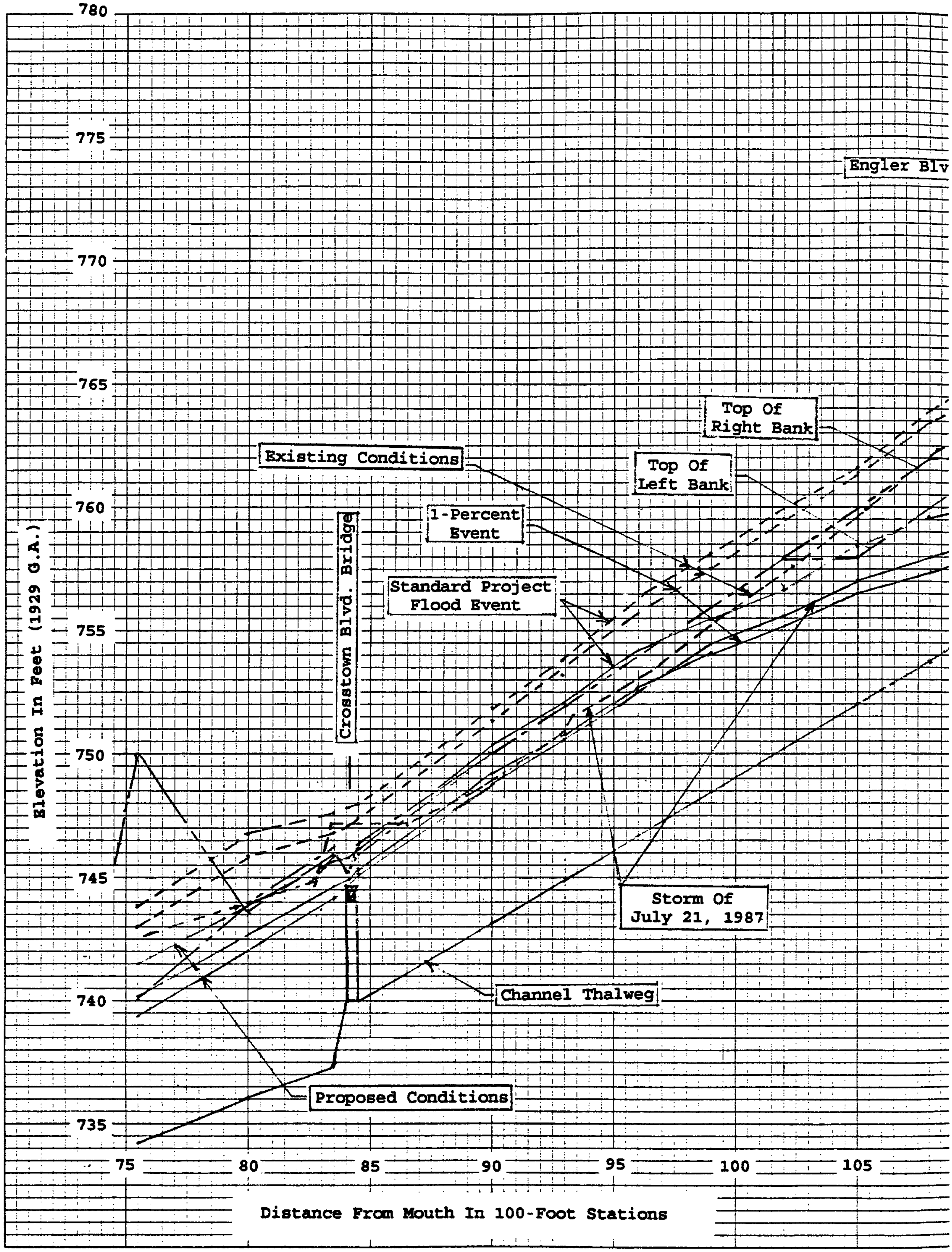
(1)



Storm Of
July 21, 1987
Standard Project
Flood Event
1-Percent
Event
C. & NW. RR. Bridge
Highway 212 Bridge
Existing Conditions
Proposed Conditions
Top Of Left Bank
Top of Right Bank
Minnesota River At Chaska, Minnesota
Stage 3 Feature Design Memorandum
Flood Control Project
PROFILES ALONG EAST CREEK
OUTLET D UPSTREAM TO POINT OF DIVERSION
55
60
65
70
75
80

PLATE C-10

(2)



780
775
770
765
760
755
750
745
740
735
75
80
85
90
95
100
105
Elevation In Feet (1929 G.A.)
Distance From Mouth In 100-Foot Stations
Engler Blv
Top Of Right Bank
Top Of Left Bank
Existing Conditions
1-Percent Event
Standard Project Flood Event
Crosstown Blvd. Bridge
Storm Of July 21, 1987
Channel Thalweg
Proposed Conditions

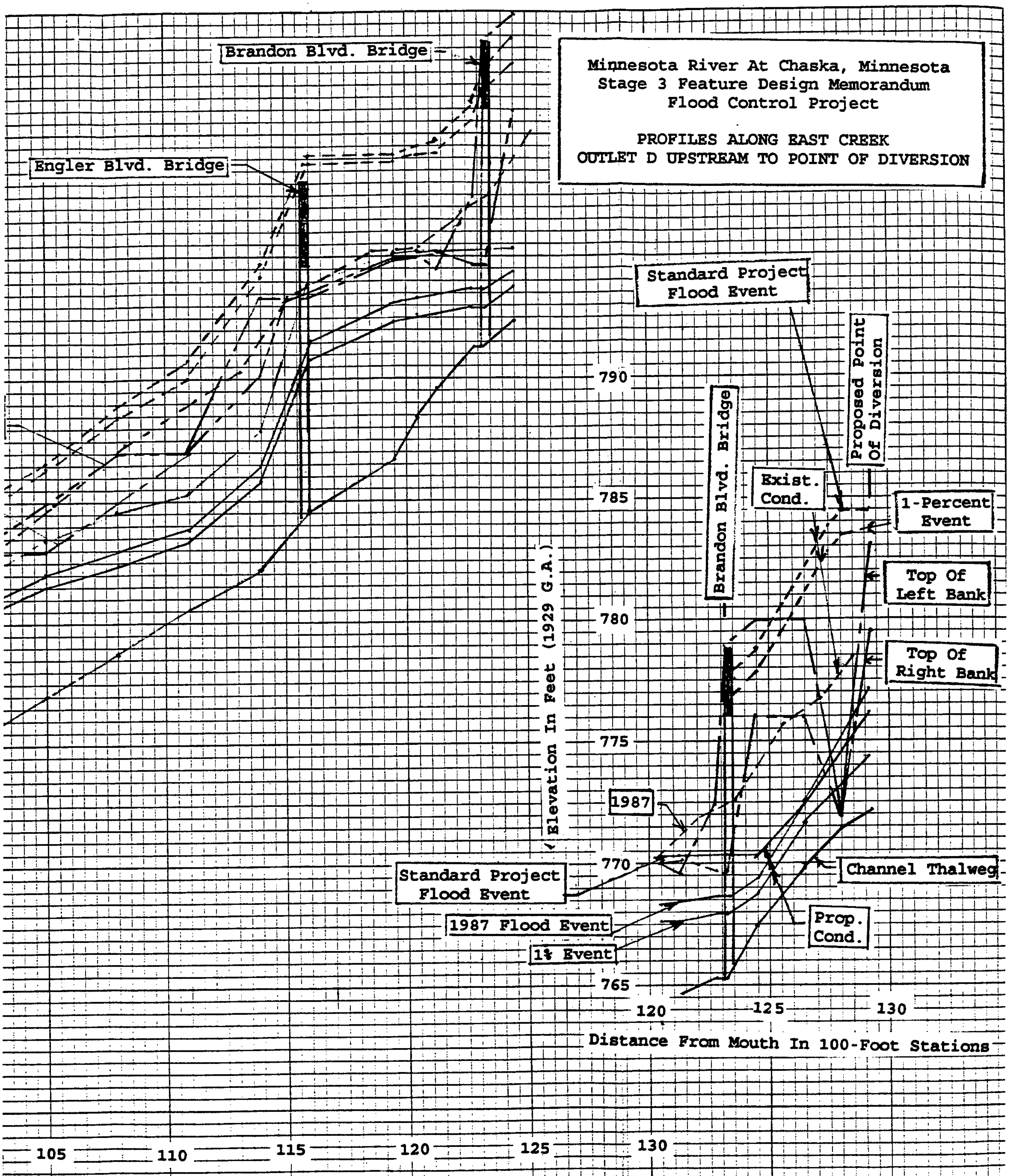
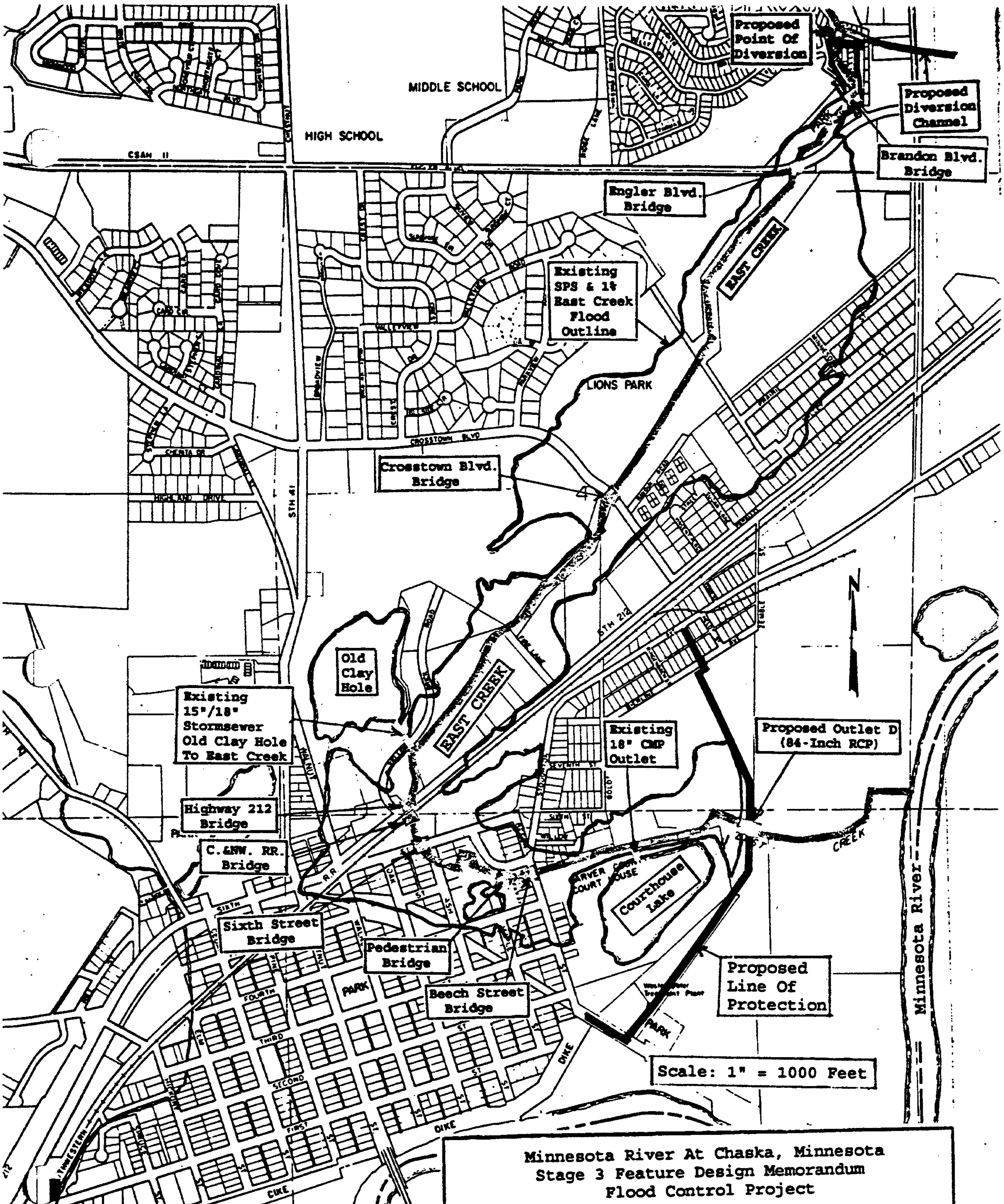


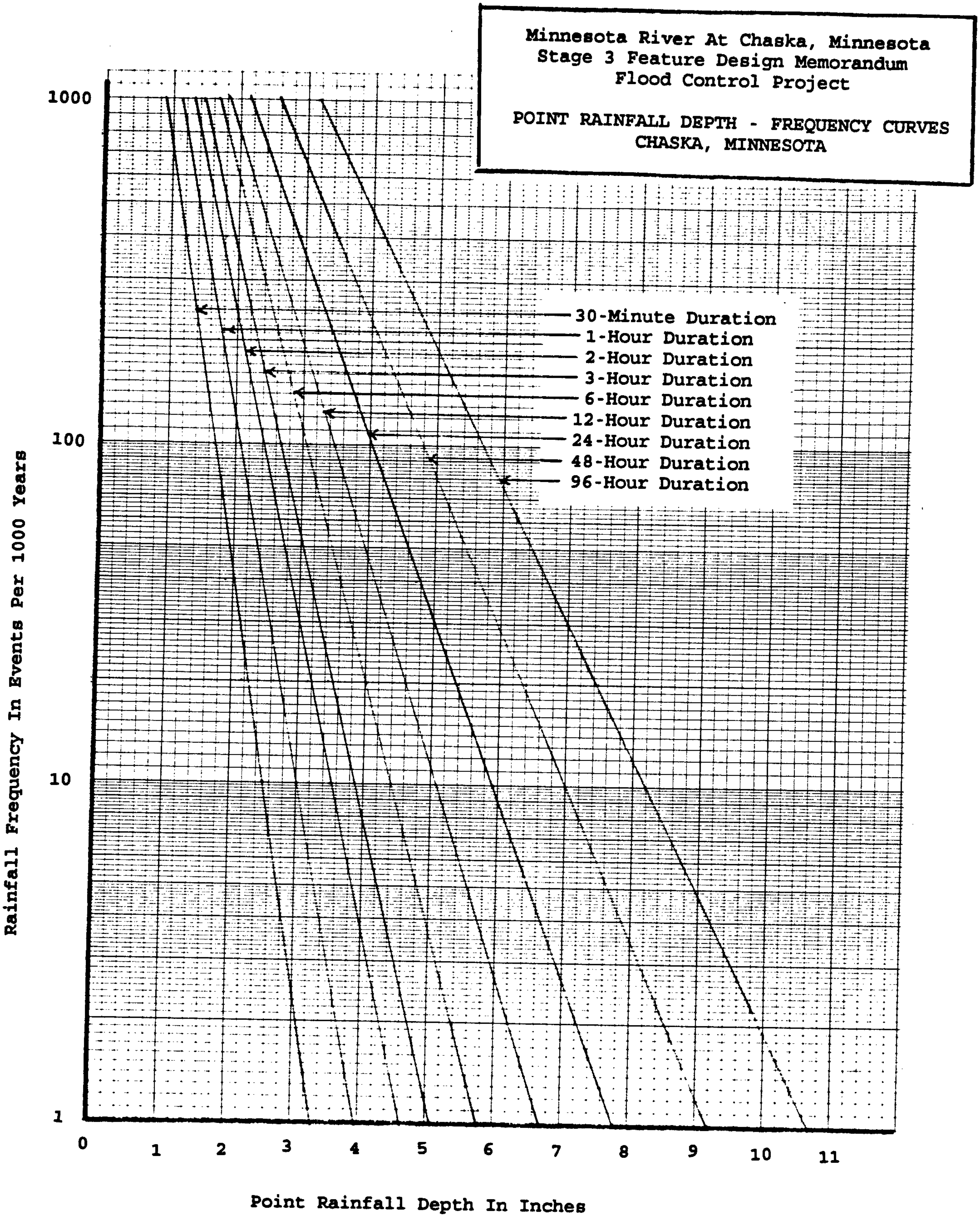
PLATE C-10 (Cont.)

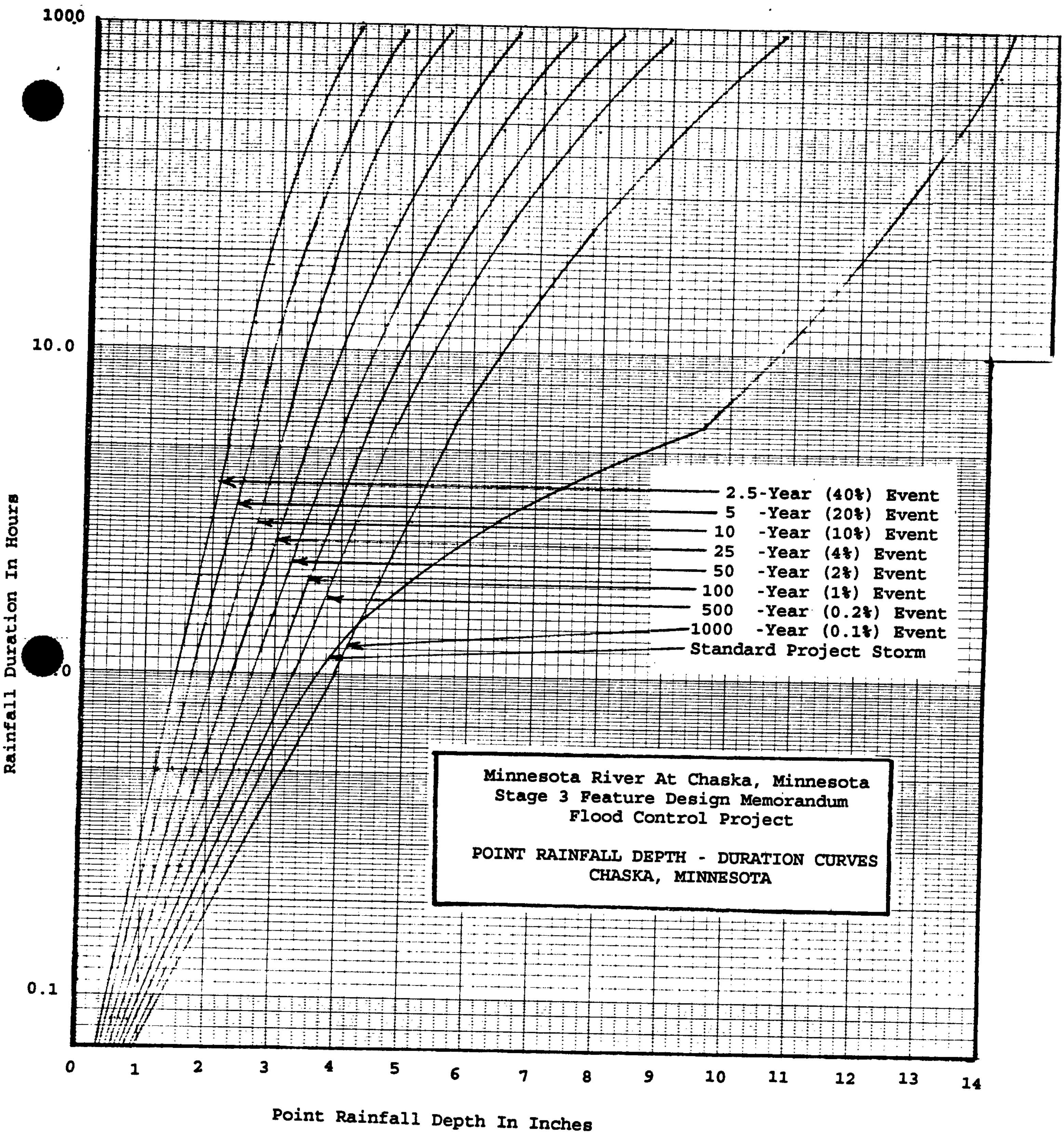


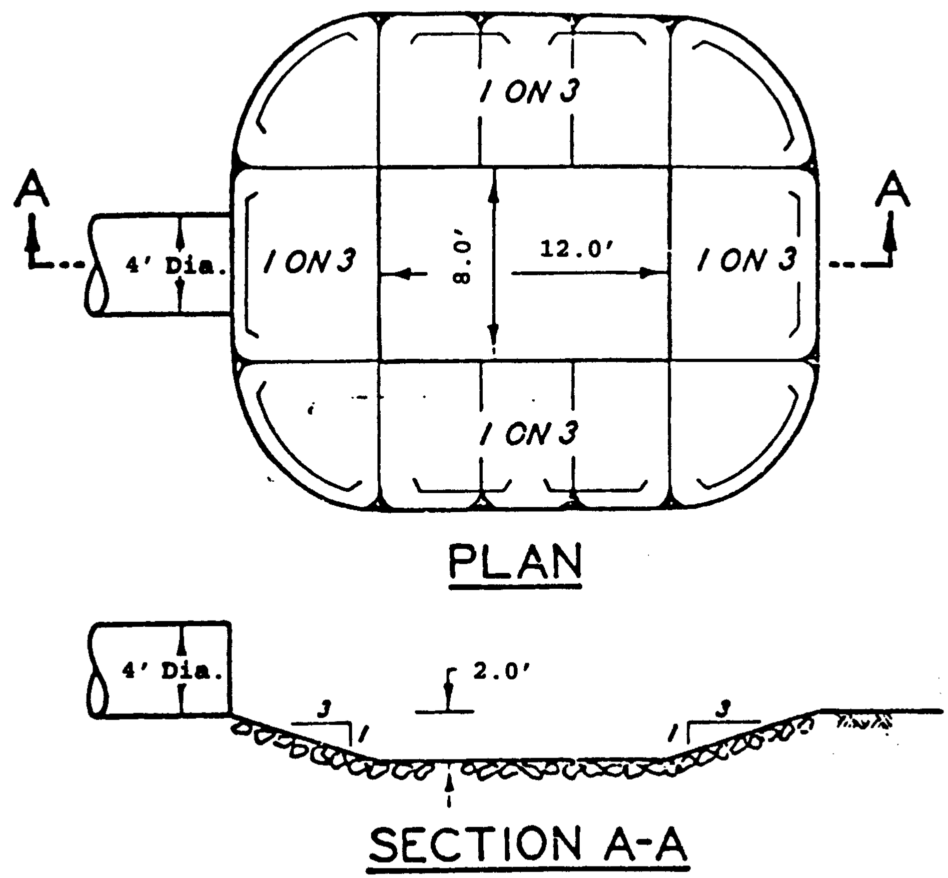
Minnesota River At Chaska, Minnesota
Stage 3 Feature Design Memorandum
Flood Control Project

LOCATION OF BRIDGES, HYDRAULIC FEATURES AND ONE PERCENT AND STANDARD PROJECT FLOOD OUTLINES ALONG EAST CREEK

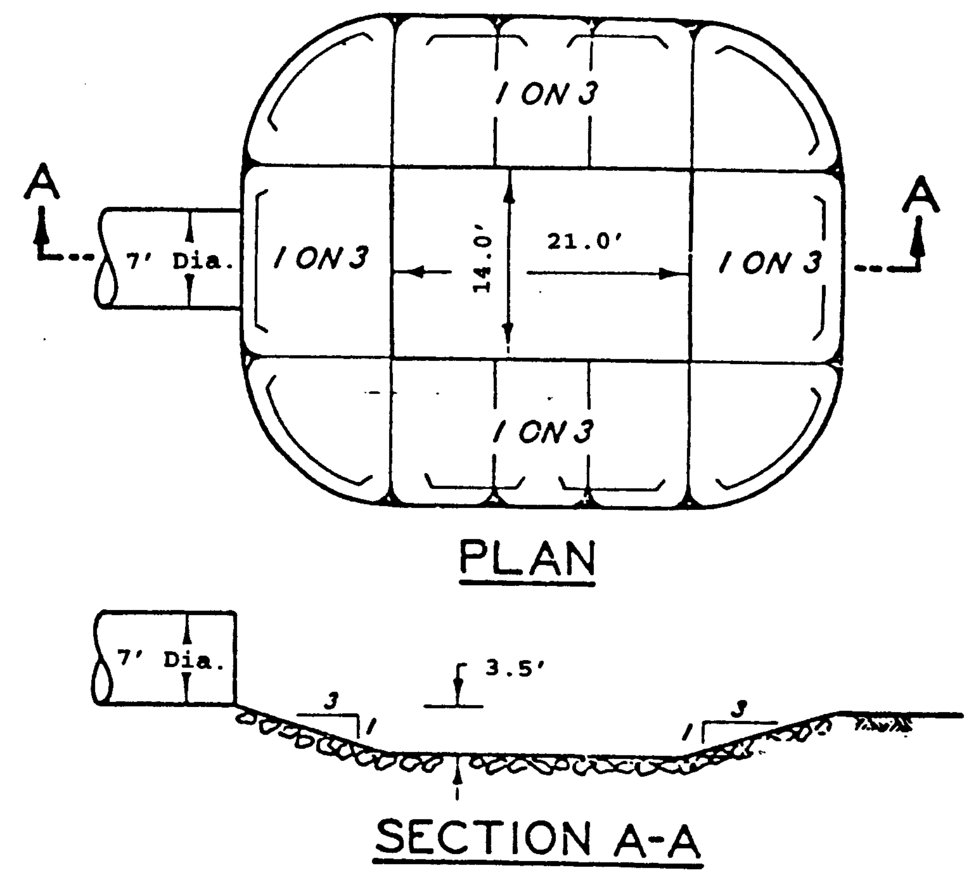
PLATE C-11


Minnesota River At Chaska, Minnesota
Stage 3 Feature Design Memorandum
Flood Control Project
POINT RAINFALL DEPTH - FREQUENCY CURVES
CHASKA, MINNESOTA
30-Minute Duration
1-Hour Duration
2-Hour Duration
3-Hour Duration
6-Hour Duration
12-Hour Duration
24-Hour Duration
48-Hour Duration
96-Hour Duration
1000
100
10
1
0
1
2
3
4
5
6
7
8
9
10
11
Rainfall Frequency In Events Per 1000 Years
Point Rainfall Depth In Inches


1000
10.0
1.0
0.1
Rainfall Duration In Hours
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Point Rainfall Depth In Inches
2.5-Year (40%) Event
5 -Year (20%) Event
10 -Year (10%) Event
25 -Year (4%) Event
50 -Year (2%) Event
100 -Year (1%) Event
500 -Year (0.2%) Event
1000 -Year (0.1%) Event
Standard Project Storm
Minnesota River At Chaska, Minnesota
Stage 3 Feature Design Memorandum
Flood Control Project
POINT RAINFALL DEPTH - DURATION CURVES
CHASKA, MINNESOTA



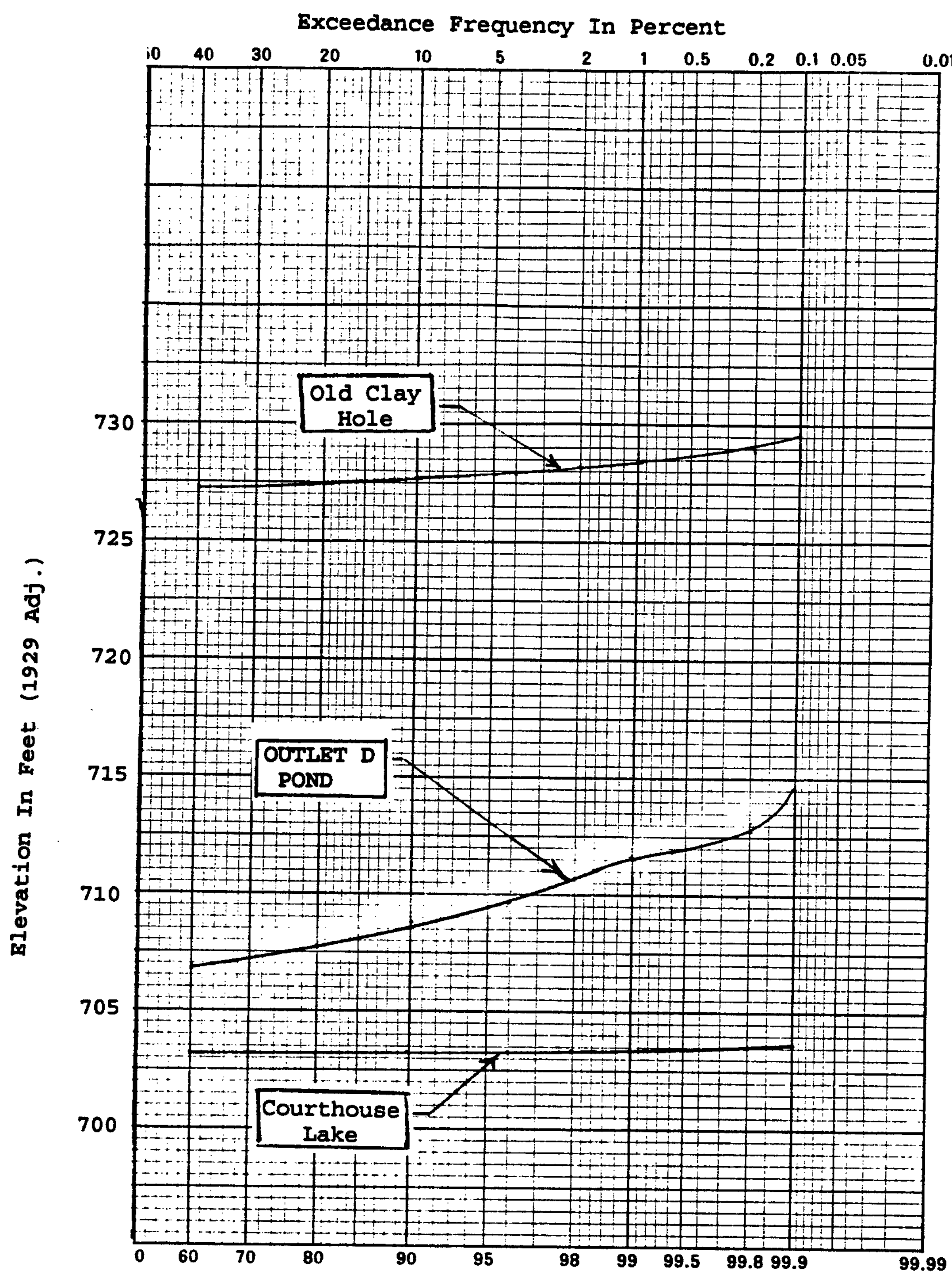
DOWNSTREAM OF OUTLET E



DOWNSTREAM OF OUTLET D

Minnesota River At Chaska, Minnesota
Stage 3 Feature Design Memorandum
Flood Control Project

PREFORMED SCOUR HOLE PLANS
FOR PROPOSED OUTLETS D AND E



Minnesota River At Chaska, Minnesota
Stage 3 Feature Design Memorandum
Flood Control Project

ELEVATION - FREQUENCY CURVES
FOR
STORAGE IN THE THREE DESIGNATED PONDING AREAS

PLATE C-15

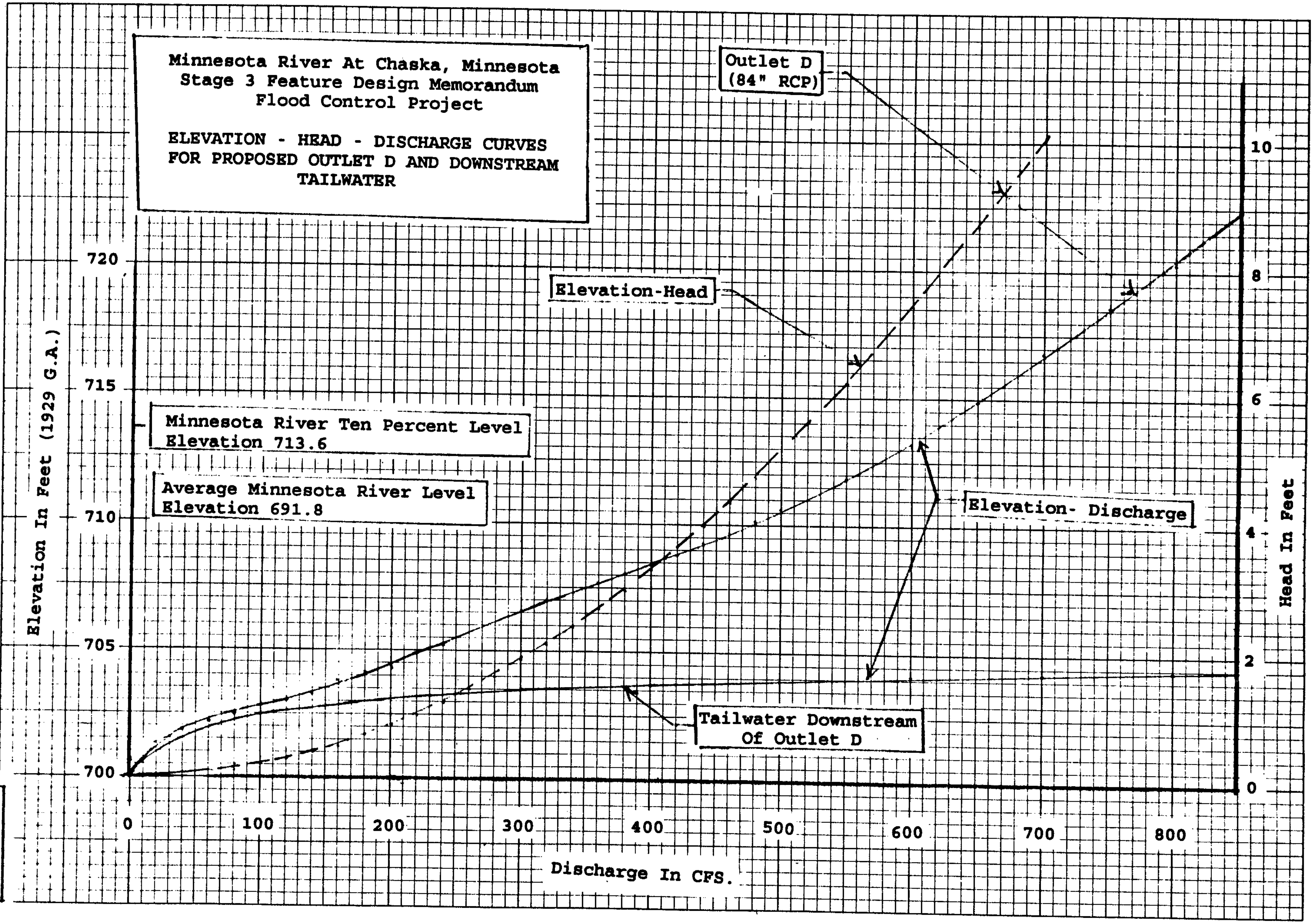

Minnesota River At Chaska, Minnesota
Stage 3 Feature Design Memorandum
Flood Control Project
ELEVATION - HEAD - DISCHARGE CURVES
FOR PROPOSED OUTLET D AND DOWNSTREAM
TAILWATER
Outlet D
(84" RCP)
Elevation-Head
Minnesota River Ten Percent Level
Elevation 713.6
Average Minnesota River Level
Elevation 691.8
Elevation- Discharge
Tailwater Downstream
Of Outlet D
Elevation In Feet (1929 G.A.)
700
705
710
715
720
Head In Feet
0
2
4
6
8
10
0
100
200
300
400
500
600
700
800
Discharge In CFS.

PLATE C-16

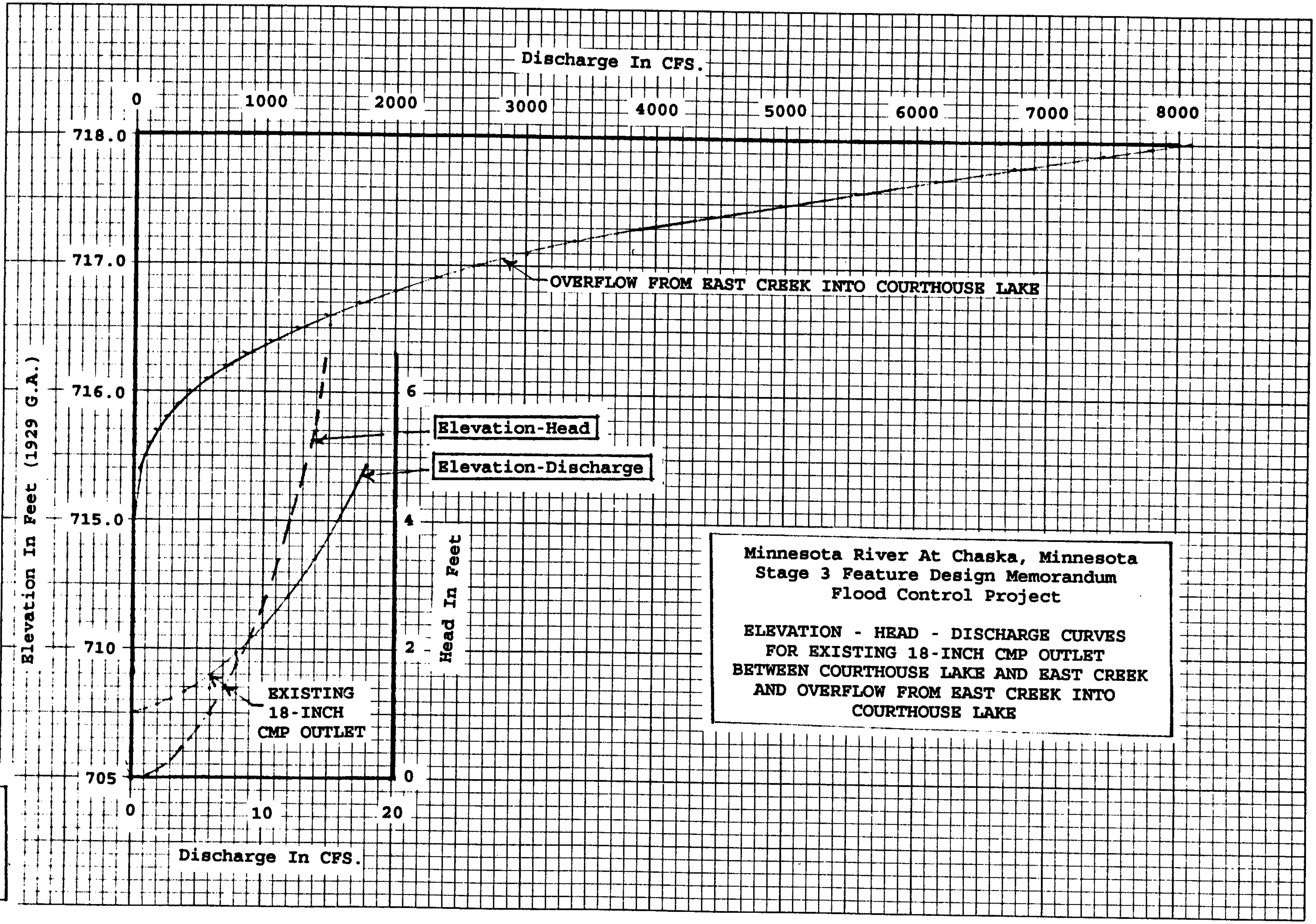

Discharge In CFS.
0
1000
2000
3000
4000
5000
6000
7000
8000
718.0
717.0
716.0
715.0
710
705
Elevation In Feet (1929 G.A.)
OVERFLOW FROM EAST CREEK INTO COURTHOUSE LAKE
6
4
2
0
Head In Feet
Elevation-Head
Elevation-Discharge
EXISTING 18-INCH CMP OUTLET
0
10
20
Discharge In CFS.
Minnesota River At Chaska, Minnesota
Stage 3 Feature Design Memorandum
Flood Control Project
ELEVATION - HEAD - DISCHARGE CURVES FOR EXISTING 18-INCH CMP OUTLET BETWEEN COURTHOUSE LAKE AND EAST CREEK AND OVERFLOW FROM EAST CREEK INTO COURTHOUSE LAKE

PLATE C-17

NO. 341-10 DIETZGEN GRAPH PAPER
10 X 10 PER INCH

DIETZGEN CORPORATION
MADE IN U.S.A.

Minnesota River At Chaska, Minnesota
Stage 3 Feature Design Memorandum
Flood Control Project

ELEVATION - HEAD - DISCHARGE CURVES
For
EXISTING 15"/18" STORMSEWER
BETWEEN OLD CLAY HOLE AND EAST CREEK AND
OVERFLOW FROM OLD CLAY HOLE TO EAST CREEK

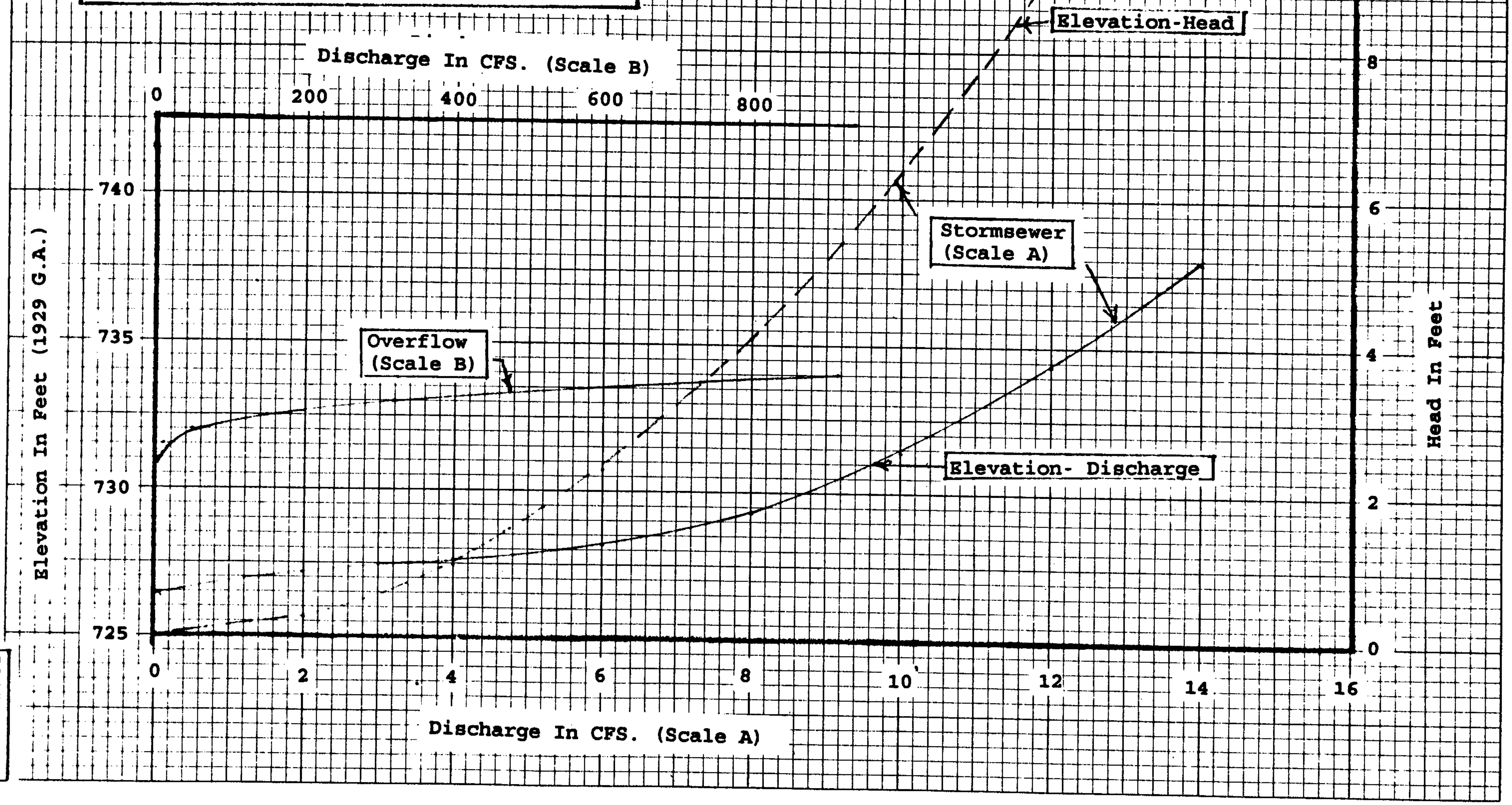


PLATE C-18

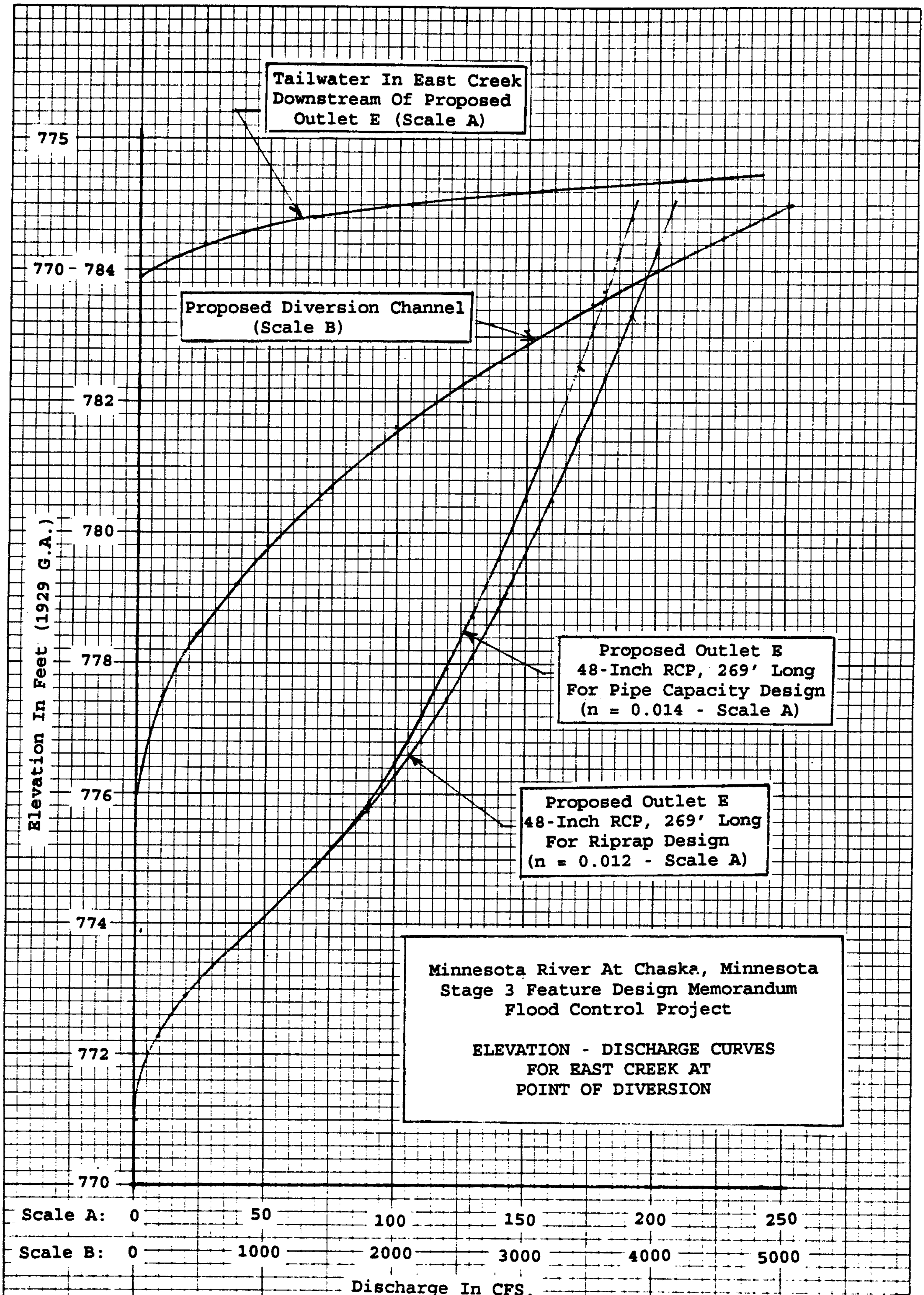

Tailwater In East Creek Downstream Of Proposed Outlet E (Scale A)
Proposed Diversion Channel (Scale B)
Proposed Outlet E 48-Inch RCP, 269' Long For Pipe Capacity Design (n = 0.014 - Scale A)
Proposed Outlet E 48-Inch RCP, 269' Long For Riprap Design (n = 0.012 - Scale A)
Minnesota River At Chaska, Minnesota
Stage 3 Feature Design Memorandum
Flood Control Project
ELEVATION - DISCHARGE CURVES
FOR EAST CREEK AT
POINT OF DIVERSION
Elevation In Feet (1929 G.A.)
775
770 - 784
782
780
778
776
774
772
770
Scale A: 0 50 100 150 200 250
Scale B: 0 1000 2000 3000 4000 5000
Discharge In CFS.

PLATE C-19

APPENDIX D

GEOTECHNICAL DESIGN

EAST CREEK AT CHASKA, MINNESOTA
STAGE 3 FEATURE DESIGN MEMORANDUM
FLOOD CONTROL PROJECT

CHASKA STAGE 3

APPENDIX D

GEOTECHNICAL DESIGN

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D-10 thru D-15	90-134M thru 92-170M	AL,MC,& MA
D-16 thru D-18	92-170M thru 92-174M	AL,MC,& MA
D-19 thru D-20	92-195M thru 92-204M	AL,MC,& MA
D-21 thru D-40	82-42M	AL,MC,MA,H,SG,Q,R, & C
D-41 thru D-59	90-132M	AL,MC,MA,H,SG,UC,R, & C
D-60 thru D-81	90-133M	AL,MC,MA,H,SG,UC,R, & C
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D-112 thru D-172	90-139M	AL,MC,MA,H,SG,UC,Q,R, & C
D-173 thru D-199	90-143M	AL,MC,MA,H,SG,UC,Q,R, & C
D-200 thru D-212	91-144M	AL,MC,MA,H,SG,Q,R, & C
D-213 thru D-231	91-148A	AL,MC,MA,SG, & C
D-232 thru D-239	92-169M	AL,MC,MA,H,SG,Q, & R
D-240 thru D-274	92-171M	AL,MC,MA,H,SG,UC,R, & C
D-275 thru D-282	92-172M	AL,MC,MA,H,SG,UC, & R
D-283 thru D-298	92-173M	AL,MC,MA,H,SG,UC, & R
D-299 thru D-345	92-195M	AL,MC,MA,H,SG,Q, & R
D-346 thru D-347	92-197M	AL,MC,MA,H,SG
D-348 thru D-355	92-198M	AL,MC,MA,H,SG,Q, & R
D-356 thru D-357	92-199M	AL,SG, & COMPACTION
D-358 thru D-391	92-200M	AL,MC,MA,H,SG,Q,R, & C
D-392 thru D-393	92-202M	AL,SG, & COMPACTION
D-394 thru D-395	92-203M	AL,SG, & COMPACTION

Note: The abbreviations used
above denote the following.

AL= Atterberg Limits
MC= Moisture Content
MA= Mechanical Analysis
H= Hydrometer Analysis
SG= Specific Gravity
Q= Unconsolidated-Undrained Triaxial Test
UC= Unconfined Compression Test
R= Consolidated-Undrained Triaxial Test w/pore pressure measurement
C= Consolidation Test

EAST CREEK AT CHASKA, MINNESOTA
STAGE 3 FEATURE DESIGN MEMORANDUM
FLOOD CONTROL PROJECT

CHASKA STAGE 3

APPENDIX D

GEOTECHNICAL DESIGN

TOPOGRAPHY

1. The proposed flood control improvements will be located within an eastern portion of the city of Chaska, in the Minnesota River Valley. The valley trends northeast and is approximately 2.5 miles wide in this reach. The floodplain of the Minnesota River in the project area lies at an approximate elevation of 705, averages 1 mile in width, and is characterized by extensive marshy areas and shallow lakes. Alluvial and bedrock terraces rise above the floodplain and form narrow, regionally prominent plateaus between elevations 700 and 800. The protected portion of Chaska is situated between the elevations of 710 and 730, at the upstream end of a terrace that trends northeast along the base of the valley wall. The river valley walls rise sharply above the floodplain and terraces to form a bluff that grades into a hummocky, poorly drained regional highland at approximate elevation 850 on the north side of the valley, and at approximate elevation 900 on the south side of the valley.

2. East Creek emerges from a deep, steep-walled ravine onto a large terrace about 1.5 miles northeast of downtown Chaska. The creek flows southwesterly across the terrace, loops through the northeast corner of the central city area, and joins the Minnesota River east of downtown Chaska. Topographic features at the mouth of the East Creek ravine indicate the presence of an alluvial fan on the terrace and a previous flowage path of East Creek near the valley wall toward the northeast. The normal low flow in the creek is sustained by groundwater discharging from pervious strata in thick deposits of glacial till that comprise the surrounding regional highlands.

REGIONAL GEOLOGY

3. The region surrounding the project area was glaciated extensively during the Pleistocene Epoch. Advancing and reteating glaciers laid down thick deposits of unsorted till and outwash sand that today form a hummocky, poorly-drained plain dotted with numerous marshes and small lakes. The glacial drift reaches a thickness of between 200 and 250 feet in the upland region and lies unconformably on dolomitic limestone and sandstone of the Prairie du Chien and Jordan Formations. The large valley of the present Minnesota River was carved by glacial River Warren, which carried large volumes of water discharging from the now-extinct glacial Lake Agassiz located in western Minnesota and eastern North Dakota. Glacial River Warren cut deeply into bedrock and formed the terraces that are prominent today. As the flows decreased,

the valley was filled to approximately its present level with alluvium. Recent borings and historic water well records indicate alluvium approximately 180 feet in thickness. The top-of-bedrock elevation is between 530 and 542. The upper bedrock in the river valley consists of weathered to slightly weathered fine-grained, silty, glauconitic sandstone of the Franconia Formation. Sandstones of the Dresbach and Hinkley Formations underly the Franconia.

SUBSURFACE INVESTIGATIONS

4. Soil borings were obtained in several phases over a substantial period of time for the East Creek diversion investigations and design. Four borings were obtained in 1980 and five in 1982 for an East Creek diversion channel and conduit plan presented in the 1982 Limited Reevaluation Report (The Reevaluation alignment was similar to the current alignment upstream (west) of County Highway 17, but proceeded south-southeast toward the Minnesota River downstream of County Highway 17, rather than the generally south heading of the current alignment in this reach.) One boring was obtained in 1988 near the proposed diversion channel inlet. Twelve borings were obtained in 1990, five in 1991 and seventeen in 1992 along the current alignment (including an earlier alternative alignment downstream of Stoughton Ave.) for this feature design memorandum.

5. The locations of borings not shown on the project plan drawings(Plates 3 to 8) are shown on Plate D-1. Boring logs are shown on Plates D-3 to D-16. Boring logs for Outlet D(Plate 9) are shown in the Stage 4 Feature Design Memorandum. Undisturbed soil samples were obtained with 3-inch Shelby tubes or a 5-inch piston sampler depending on equipment availability and limited site access conditions. The type of equipment used for undisturbed samples is indicated in the corresponding notes of applicable boring logs.

6. The results of classification, shear strength and consolidation tests performed on numerous soil samples are shown on Figures D-1 to D-395. Plates D-95 to D-98 show a summary of all testing. A significant number of the samples tested exhibited borderline classifications. This reflected the substantial variability of the alluvial deposits encountered and indicated the associated variability of engineering characteristics.

GEOLOGIC PROFILE

7. The substantial variability of alluvial deposits encountered by subsurface investigations along the alternative East Creek diversion channel alignments does not permit a clear definition of precise boundaries between depositional time periods. However, evaluation of topographic features in combination with subsurface exploration data enabled the development of a general geologic profile across the terrace and floodplain between the valley wall and the Minnesota River in the area of the proposed diversion channel. Although this geologic profile is general in nature, it was quite useful for engineering analysis and design. The subject geologic profile is shown on Plate D-2. Note the indication of glacial till in the valley wall, highly variable alluvial material within the terrace downstream from the mouth of the East Creek ravine, more uniform

sand strata within the riverward portion of the terrace, and finer-grained and more variable alluvium within the floodplain of the Minnesota River. Also note the presence of significant fill material on the surface near the downstream end of the proposed diversion channel alignment. Referring to borings 92-172M, 92-173M, 92-195M, and 92-196M on Plates 3, D-13 and D-14, note that the upper clay fill material between approximate channel stations 1+00 and 7+00 consists of lime(sugar beet processing residue) deposited by the adjacent American Crystal Sugar processing plant. Lime is no longer being deposited in this area, and the existing material is currently being mined for agricultural use. Boring 92-174M on Plates 3 and D-13 shows some fill that appears to be primarily construction debris and miscellaneous sandy material. Also worthy of note is the general ground water profile across the terrace. A more detailed picture of the soil strata and ground water profile at the time of the borings is shown on the project plan and profile drawings (Plates 3 to 8), in conjunction with the boring log drawings (Plates D-3 to D-16).

8. The geologic profile (Plate D-2) along the channel alignment can be separated into four parts based on stratigraphic relationships determined from soil borings and well logs:

Sta. 0+00 to 9+00: From the confluence of East Creek Diversion Channel and the Minnesota River to about Sta. 9+00, an agricultural lime pile on top of an organic clay deposit overlies fluvial sand which extends to an undefined depth. The organic clay deposit was once utilized by the sugar plant as a settling pond for sugar beet residue. Strong organic odors were detected from soil samples taken from this unit. The clay deposit appears to be hydrologically connected to the fen complex located to the east of the channel alignment. The high water table and numerous seeps along this section of the alignment originate from the sandy aquifer located below the organic clay deposit and the agricultural lime pile.

Sta. 9+00 to 28+00: Upstream of approximate Sta. 9+00, the profile stratigraphy shows thick deposits of alluvial sand. The alluvial sand deposit underlies the entire channel alignment. Recent borings and historic water well records indicate alluvial thicknesses of at least 180 feet above the bedrock surface. It is Chaska's primary alluvial aquifer. Upstream of Stoughton Avenue it forms an alluvial terrace which extends to the valley wall. The terrace is a regionally prominent feature found throughout the Minnesota River Valley. The alluvial sand deposit is poorly graded and differentiated by minor amounts of silt and occasional gravel. The sand was most likely derived from the glacial drift of the upland region and fluvially deposited as glacial outwash.

Sta. 28+00 to 36+00: A transition zone occurs on the alluvial terrace between the fluvial outwash deposits downstream of approximate Sta. 28+00, and the alternating strata of pervious and cohesive alluvial fan stratigraphy upstream of approximate Sta. 36+00. The transition zone marks the downstream edge of a confining till unit beneath the alluvial deposits. The water table gradient shown on the profile reflects the change in stratigraphy through this part of the alignment. The gravel deposits are the result of fluvial processes.

Sta. 36+00 to 61+25: Alternating strata of impervious organic clay layers and pervious granular deposits overlie a confining unit of

glacial till through this part of the channel alignment. The till unit overlies the alluvial aquifer. In borings where the aquifer was penetrated through the confining till unit near Sta. 45+00 and Sta. 46+00, significant artesian pressures were encountered. Flowing conditions with heads exceeding 13 feet above the ground surface were observed. However, at approximate Sta. 54+00, a boring which penetrated the aquifer beneath the till unit showed no flowing conditions at the time of the boring. The artesian pressure which exists through this part of the alignment accounts for the elevated water table shown on this section of the profile.

PROJECT FEATURES

9. A 6000 foot channel will control drainage from East Chaska Creek and discharge directly to the Minnesota River. Where design constraints limited the depth of excavation, levees will be constructed to contain the design discharge. The typical levee section will have 1V to 3H side slopes and a top width of 10 feet. Fill for the levee will be impervious. A bituminous trail on an aggregate base will be located on the west side of the channel downstream of drop structure number 4 and on both sides of the channel upstream of drop structure number 4. Erosion protection will generally consist of riprap on the channel side of the levees. Areas not receiving riprap will receive top soil and seeding. Levees will be constructed with a cutoff trench which will have a 6 foot bottom width and side slopes no steeper than 1V to 1H. Trench depth will be 6 feet for levee heights equal or greater than 6 feet. For levee heights less than 6 feet, the trench depth will be equal to the levee height.The trench will be backfilled with impervious material. The project site will be landscaped.

10. Drop structures will be located at stations 8+50, 15+00, 32+50, and at 51+50. The bottom width of the drop structures varies from 30 to 40 feet. A short transition will be provided upstream and downstream of the drop structures to transition from drop structure width to channel width.

11. Bridges will be located at Stoughton Avenue(station 17+00), Highway 212(station 25+00) and Engler Boulevard(station 46+00).

12. Station 0+00 to 3+75,will consist of the trapezoidal channel chute and a tailwater control dike. The channel will be approximately 250 feet wide. Articulated concrete slope protection will be used because of the high channel velocities. Channel side slopes will be 1V:4H.

13 Station 3+75 to 8+25 will consist of a trapezoidal channel with flanking levees. The channel width will vary from 250 to 50 feet and side slopes will be 1V:4H. Erosion protection will be provided by topsoil and seed except directly downstream of Drop Structure 1 where riprap will be provided.

14. Station 8+62 to 14+62 will consist of a trapezoidal riprapped channel with a 10 foot bottom width and flanking levees. Levee side slopes will be 1V:3H above station 8+62. The flanking levees will be provided with a landside pervious toe drain.

15. Station 15+18 to 32+54 will consist of a trapezoidal riprapped channel with a 10 foot bottom width.

16. Station 33+01 to 45+88 will consist of a trapezoidal riprapped channel with with a 25 foot bottom width and flanking levees. Beginning at approximately station 43+00 the new Highway 17 road embankment will be used as the levee on the east side of the channel.

17. Station 46+60 to 51+40 will consist of a 25 foot wide trapezoidal riprapped channel with flanking levees. The new Highway 17 road embankment will be used as the levee on the east side of the channel. The new Engler Blvd. embankment and the existing Highway 17 road embankment will provide the flanking levee on the west side of the channel.

18. Station 51+88 to 59+52 will consist of a 10 foot wide trapezoidal riprapped channel with flanking levees. Outlet E will be located in the existing east creek channel.

19. Outlet D will be placed through the Stage 4 Chaska levee after consolidation is complete. The existing East Creek diversion opening through the Stage 4 levee will then be filled.

GROUND WATER CONSIDERATIONS

-- GENERAL

20. Based on the ground water levels encountered during subsurface exploration, the bottom of the proposed diversion channel will be at or beneath the existing ground water table within the general area of the East Creek alluvial fan (upstream of approximately station 30+00) and near the toe of the sand terrace (downstream of approximately station 15+00). Consideration was given to the effects of the drainage measures along the channel on the adjacent wetlands at the downstream end of the channel. The channel will have minimum impact on these wetlands. Ground water seepage from the banks of the diversion channel will also be a concern within the reach between stations 30+00 and 52+00. The artesian pressure in this reach has an effect on the channel design. Note the 10 foot difference in water levels between borings 90-139M, 92-202M and 92-203M which shows there may be a considerable seasonal or yearly variation in the water table. The borings and geologic profile indicate the underlying aquifer at the site will have confined flow from station 0+00 to 9+00 and 30+00 to 60+00. Unconfined flow appears to exist from 9+00 to 30+00.

-- DRAWDOWN OF THE GROUNDWATER TABLE

21. Wherever the channel invert will be below the existing groundwater table there will be some localized drawdown of the water table. The two main areas of concern are near drop structure number 1 where the channel will be adjacent to the fen and near the intersection of Engler Boulevard and County Highway 17.

22. The channel should have a minimal impact on the fen which is located east of the channel between stations 0+00 and 12+00. A large drawdown of the water table near the fen could affect the groundwater flow and cause degradation of the fen. Calculations indicate that the radius of influence from a one foot lowering of the groundwater at the drop structure would not affect the fen. Lowering the water table two

feet should only have minimal impact on the fen. The radius of influence that has been calculated will be conservative because it does not account for the partial penetration of the channel into the aquifer or for the uneven ground surface. It was originally thought a liner would be required to prevent the water table from being lowered from approximately elevation 717 at the drop structure at station 8+50 to 710 or 711 because water would flow through the bedding and under the culvert in the tailwater control structure located at station 3+50. The radius of influence of the 6 or 7 foot drop might have affected the fen. The planned alternative which deleted a low flow channel should only allow drawdown to a little below elevation 715. The insitu soils downstream of the 24 inch riprap(~7+50) are sufficiently impervious to prevent further drawdown of the water table. Calculations are shown on Plate D-17.

23. Drawdown of the water table near Engler Boulevard and Highway 17 may induce settlement in the three buildings closest to the channel and the adjacent roads. A finite element analysis, using COE program X8202, indicated a maximum possible drawdown of 7' at 100' and a minimum drawdown of 0' at 50' from the toe of the channel slope. The drawdown is greatly affected by the assumed permeabilities of the individual soil layers and the assumed boundary conditions. When higher permeabilities are used for impervious layers the artesian pressure tends to reduce the amount of drawdown, when lower permeabilities are used the artesian pressure has almost no effect on the amount of drawdown. The model assumes pervious material at the bottom of the channel. If there is clay at the bottom of the channel large uplift pressures are generated. The model does not include the riprap and bedding at the channel invert which may result in additional drawdown. Calculations are shown on Plates D-18 to D-20.

-- UPLIFT

24. Uplift from artesian pressures upstream of station 33+00 dictated the depth of the channel in that reach. Boring 92-204M, drilled to elevation 668, did not encounter artesian pressures. Borings 90-134M and 92-200M encountered the confined flow region at approximately elevation 705. A well log from an abandoned city of Chaska well near Outlet E indicated some artesian pressure at that location. The well log(see Plate D-92) shows the bottom of the confining clay layer at elevation 715 and the bottom of the screen at elevation 669. The factor of safety against uplift was determined by dividing the buoyant soil weight above the confining layer by the excess pressure head. A saturated soil weight of 110 pcf was used. The soil profile from boring 90-134M was used. Artesian pressure below the confining layer was assumed to be equivalent to a water level to elevation 779. With a channel invert elevation of 752 the factor of safety against uplift will be approximately 1.3. This factor of safety should be adequate since a failure of the channel bottom would not be catastrophic but might only cause additional maintenance. With a channel invert at elevation 755 the factor of safety would be approximately 1.5(the channel invert is at elevation 755 at approximately station 44+50). The calculations assume no flow through the confining layer. If the confining layer is not continuous or effectively impermeable, the pressure will be dissipated through either horizontal or vertical flow paths and the factor of safety may be less than anticipated. Additional borings to determine this would not be economically feasible and if problems are encountered during

construction they will need to be solved at that time.

-- SEEPAGE

25. Levee through-seepage and underseepage are generally not a problem for the proposed diversion channel plan, because the required levee heights are quite low, the proposed levee fill material is impervious, and substantial semi-pervious to impervious top strata are present within the upper levee reaches. An exception to this is at Gatewell E where the levee height is substantial and a relatively thin semipervious top blanket is underlain by a pervious foundation material. There is also an area between drop structures 1 and 2 where a thin semipervious stratum covers pervious foundation materials.

26. A cutoff trench will be excavated along the levee centerline to cut off pervious or semipervious soil layers near the ground surface.

27. Levee underseepage and uplift calculations were made at several locations along the channel. Criteria and methods used in the analysis were from EM 1110-2-1913 which require a minimum factor of safety of 1.5 against uplift and a maximum allowable upward gradient of 0.5 at the levee toe. Horizontal permeabilities for the pervious layer under the levees were based on D10 sizes and Figure 3-5 in EM 1110-2-1913. The vertical permeabilities of the landside top stratum were obtained from Table 38 in TM 3-424. Seepage quantities were calculated using the design water surface elevation. Uplift pressures were calculated using the water surface at the top of the levee.

28. A toe drain will be provided downstream of Stoughton Avenue(from station 8+62 to 14+62) to keep uplift pressures within safe levels. The drain will be five feet deep and thirteen feet wide at the base of the trench. The drain will be SP or SW material from the required excavation. CSEEP(X8202) was used to determine the required width of the drain. Levee underseepage and uplift calculations are shown on Plates D-21 to D-25.

29. The new Highway 17 road embankment will be used as the levee on the east channel bank north of station 43+00(see Plate 7). A typical cross section of the Highway 17 embankment is shown on Plate D-28. The top of the embankment is 100 feet wide. The side slopes are 1V:3H. The geotextile was equivalent to Mirafi 500X. The pervious fill has less than 5% passing the number 200 sieve and less than 35% passing the #40 sieve. One foot of MnDOT 3149.2B Select Granular Borrow with less than 35% passing the #40 sieve was placed directly below the pavement. The majority of the embankment fill is clay. The embankment was analyzed as if the three foot sand layer ran under an impervious levee. A finite element analysis(using the COE X8202 finite element seepage program) showed the exit gradient was less than 0.5 which means the embankment will be suitable to use as the levee. The input parameters are shown on Plate D-29. It is anticipated that a portion of the 4" pipes can be grouted full to prevent direct water passage under the embankment.

30. A pervious seepage berm has been placed at the downstream levee toe at Outlet E(station 59+50) to keep uplift pressures and exit gradients within safe levels. Boring 80-33M was used for the levee underseepage analysis near outlet E, although the boring did not reach the bottom of the pervious zone it has been assumed to end at the bottom of the boring

based on the geologic soil profile. Calculations are shown on Plates D-30 to D-34.

31. The drop structures were checked to determine if piping of materials might be a problem using a creep path along the structures and Lane's weighted creep ratio equation. The calculations showed piping of materials could occur at all drop structures. This will be prevented by placing reverse filters at the downstream side of all structures. Creep ratio calculations are shown on Plates D-35 to D-36.

32. The drop structures were checked to insure the exit gradients would be 0.50 or less using the COE program CFRAG which uses the Method of Fragments to determine seepage pressures and flow quantities. Horizontal permeabilities for the pervious layer under the drop structure were determined in the same manner as for the levee underseepage and uplift analysis. Vertical permeabilities were assumed to be one fourth of the horizontal permeabilities. Exit gradients were determined using the head differential between the upstream and downstream levee heights or the head differential between the drop structure's upstream and downstream sill elevation, whichever was greater. The wingwall analysis assumed a fictitious slab between the upstream and downstream walls to maintain confined flow so the CFRAG computer program could be used. This analysis determined additional "cutoffs" were required under all the drop structures. Calculations are shown on Plates D-37 to D-40.

33. Potential seepage along any conduits through the levees and the associated exit gradients which can cause piping of levee material, will be controlled by the placement of pervious drainage fill around the landside one-third of the conduit lengths, in accordance with guidance presented in EM 1110-2-1913. Impervious fill will placed around the riverside two-thirds of any conduit.

SLOPE STABILITY

34. Criteria for the slope stability analyses were taken from EM 1110-2-1913. Design conditions analyzed include end of construction, intermediate river stage, and steady seepage from full flood stage. The sudden drawdown case was not analyzed since the duration that the channel will be flowing will be too short to saturate the impervious levees. Computations were done using the computer program UTEXAS2 (program number I0029). The actual possibility of the levees or foundation soils becoming saturated as shown during the intermediate river case or steady seepage case is also questionable although these cases are included.

35. The in situ foundation soils were grouped according to material type, Standard Penetration Test results, and location within the same geological stratum. Foundation soil strength parameters are based on shear strength envelopes developed from triaxial compression test results as outlined in EM 1110-2-1902 and EM 1110-2-1913. Soil strength data was reduced by plotting the top point of the Mohr's circles and using the equations "tan(alpha)=sin(phi)" and "c=(a)*sec(phi)". Strength parameters for granular soil layers without test results are based on the NAVFAC DM-7.1, May 1982. If triaxial compression test results were not available for a soil layer in question, parameters from a similar material of a near-by boring were used.

36. The soil strengths used in the stability analyses at station 1+60, for the typical section in the lime pile are given below. Foundation soil parameters for material types 1 and 2 are based on shear strength envelopes (see Plates D-41 to D-46) developed from triaxial compression test results. The lime and the soft organic soil layers at the lime pile had unusually high consolidated-drained(S) strength envelopes, resulting in phi values of 32-38 degrees. For design purposes, an effective phi value of 30 degrees was used.

Table D-1: Foundation Soil Parameters below Lime Pile (Station 1+60)

	Material Type	Drainage Condition	Shear Strength Cohesion (psf)	Shear Strength Phi (deg.)
1.	MH (Lime)	Q (U-U)	400	0
		R (C-U)	240	20
		S (C-D)	0	30
2.	OL,SM,OH (Organic)	Q (U-U)	600	0
		R (C-U)	180	19
		S (C-D)	0	30
3.	SP,SP-SM (Semi-Pervious)	All	0	30

37. The soil strengths used in the stability analyses at station 7+00 and station 9+00 are given below. Foundation soil parameters for material type 2 are based on shear strength envelopes (see Plates D-47 to D-49) developed from triaxial compression test results.

Table D-2: Foundation Soil Parameters outside Lime Pile (Station 7+00 and 9+00)

	Material Type	Drainage Condition	Shear Strength Cohesion (psf)	Shear Strength Phi (deg.)
1.	CL	Q (U-U)	450	5
	LEVEE	R (C-U)	500	9
	FILL	S (C-D)	0	29.5
2.	MH,OH (Organic)	Q (U-U)	170	0
		R (C-U)	105	17
		S (C-D)	0	30
3.	SP	All	0	30
4.	SM	All	0	28

38. The soil strengths used in the stability analyses at station 42+50,

for the typical section between the two upstream drop structures are given below. The strengths for materials 1 and 3 were based on tests from boring 92-200MU.

Table D-3: Foundation Soil Parameters at Station 42+50

	Material Type	Drainage Condition	Shear Strength Cohesion (psf)	Shear Strength Phi (deg.)
1.	CH,CL,SC	Q (U-U)	380	0
		R (C-U)	62	20
		S (C-D)	0	30
2.	ML,SW-SM, SM	All	0	27
3.	CL,CL-ML ML	Q (U-U)	1360	0
		R (C-U)	847	23
		S (C-D)	0	30
4.	SW-SM,SM	All	0	30
5.	CL LEVEE FILL	Q (U-U)	450	5
		R (C-U)	500	9
		S (C-D)		29.5

39. Boring 90-134MU and 92-169MU provided the necessary geologic information to develop the foundation soil parameters near boring 90-134M. Foundation soil parameters for material type 2 are based on shear strength envelopes (see Plates D-50 to D-52) developed from triaxial compression test results. Table D-4 summarizes the results.

Table D-4: Foundation Soil Parameters Upstream of Engler (Station 48+00)

	Material Type	Drainage Condition	Shear Strength Cohesion (psf)	Shear Strength Phi (deg.)
1.	CL	Q (U-U)	340	0
		R (C-U)	950	15
		S (C-D)	0	30
2.	SC	Q (U-U)	460	0
		R (C-U)	520	20
		S (C-D)	0	32
3.	SP,SP-SM	All	0	29
4.	not used	NA	NA	NA

5.	CL	Q (U-U)	920	0
		R (C-U)	730	18
		S (C-D)	0	30
6.	SP-SM	All	0	33

40. The in situ foundation soils were grouped according to the information contained in boring 90-139MU and 92-171MU. Plates D-53 to D-64 represent shear strength envelopes developed for material type 1, 2, 3 and 4. Table D-5 summarizes the results.

Table D-5:Foundation Soil Parameters Upstream of Highway 17 D.S. (Station 53+00)

	Material Type	Drainage Condition	Shear Strength Cohesion (psf)	Shear Strength Phi (deg.)
1.	CL	Q (U-U)	340	0
		R (C-U)	950	15
		S (C-D)	0	30
2.	CL	Q (U-U)	920	0
		R (C-U)	730	18
		S (C-D)	0	30
3.	SM,SC	Q (U-U)	430	0
		R (C-U)	390	18
		S (C-D)	0	32
4.	SC-SM	Q (U-U)	1060	0
		R (C-U)	350	30
		S (C-D)	0	33
5.	CL	Q (U-U)	450	5
	LEVEE	R (C-U)	500	9
	FILL	S (C-D)		29.5
6.	SW-SM	All	0	32
7.	SP	All	0	35

41. Foundation soil parameters for Outlet E are tabulated below. The geologic profile formed by boring 88-98M and 80-33M represent the basis by which in situ foundation soils were grouped.

Table D-6: Foundation Soil Parameters at Outlet E

Material Type	Drainage Condition	Shear Strength Cohesion (psf)	Shear Strength Phi (deg.)

1.	CL LEVEE FILL	Q (U-U)	450	5
		R (C-U)	500	9
		S (C-D)		29.5
2.	SP,SP-SM	All	0	30
3.	CL	Q (U-U)	340	0
		R (C-U)	950	15
		S (C-D)	0	30
4.	SP,SP-SM	All	0	28
5.	SM,SP	All	0	34
6.	CL	Q (U-U)	920	0
		R (C-U)	730	18
		S (C-D)	0	30
7.	CL	Q (U-U)	1100	0
		R (C-U)	730	18
		S (C-D)	0	30

42. The in situ foundation soils were characterized as clay that will be continuously saturated with the soil parameters tabulated in Table D-7. The analyses of Outlet D are contained in the Stage 4 Final Design Memorandum.

Table D-7: Foundation Soil Parameters at Outlet D

	Material Type	Drainage Condition	Shear Strength Cohesion (psf)	Shear Strength Phi (deg.)
1.	Impervious Fill	Q (U-U)	1000	20
		R (C-U)	500	9
		S (C-D)	0	29.5
2.	soft foundation soils	Q (U-U)	300	0
		R (C-U)	270	13
		S (C-D)	0	28
3.	firm foundation soils	Q (U-U)	1200	0
		R (C-U)	600	18
		S (C-D)	0	27

43. The results of the slope stability analyses are given below. The results for the end of construction analysis at station 7+00 and 9+00 are lower than required but the consolidation of the foundation soils from the load of the levee embankments should increase the factors of safety to the required level within a short period of time. The levee fill from station 8+62 to 10+00 should be placed and allowed to consolidate foundation soils prior to the channel excavation in that area. Although the result for the steady seepage case at station 7+00

is lower than required it should be acceptable as it is very unlikely that the steady seepage condition will ever develop. Some of the sections analyzed and the critical surfaces obtained are shown on Plates D-65 through D-81.

Table D-8: Summary of Slope Stability Analyses

Stability Case	Factor of Safety Required*	Factor of Safety Computed
II.End of Construction		
Station 1+60(lime pile)	1.3	1.6
Station 7+00(mat. 2:c=170 psf)	1.3	1.1
(F.S.=1.5 w/mat. 2:c=250 psf)		
Station 9+00 (mat.2:c=170 psf)	1.3	0.8
(F.S.=1.3 w/mat. 2:c=300 psf)		
Station 42+50	1.3	1.3
Upstream of Engler	1.3	1.8
Upstream of Hwy 17	1.3	1.3
Outlet E	1.3	1.6
IV.Sudden Drawdown	1.0	NA
V.Intermediate River Stage		
Station 1+60	1.4	1.8
Station 42+50	1.4	1.4
Upstream of Engler	1.4	1.6
Upstream of Hwy 17	1.4	1.5
Outlet E	1.4	1.6
VI.Steady Seepage from Full Flood Stage		
Station 1+60(lime pile)	1.4	NA
Station 7+00	1.4	1.3
Station 9+00	1.4	1.4
Station 42+50	1.4	1.6
Upstream of Engler	1.4	NA
Upstream of Hwy 17	1.4	1.5
Outlet E	1.4	1.4

*As stated in EM 1110-2-1913

SETTLEMENT

44. At all of the proposed drop structures, a net unloading will occur for the main chamber of the structures. Except for Drop Structure 1 satisfactorily competent foundation strata also appear to exist beneath these structures. Some overexcavation will be required underneath the adjacent wingwalls to minimize settlement. In general the overexcavation will be uniform under the drop structures and the adjacent retaining walls. The following table indicates the overexcavation required at each drop structure.

Table D-9: Summary of Settlement Overexcavation

Drop Structure	Boring	Minimum Excavation Depth(elevation)
2	90-136M	725
3	92-199M	735
4	92-171M	750
4(wingwalls)	90-139M	755

45. A surcharge will be used in addition to dewatering to improve the foundation strength at Drop Structure 1. The surcharge height will be chosen to approximate the maximum footing load of the downstream retaining walls(5000 psf).

46. Calculations for the east side of the channel at approximately station 7+00 show primary consolidation settlements of 1.7' and 2.7' for fill heights of 5' and 10' respectively. For quantity purposes a two foot overbuild will be used downstream of the drop structure at 8+50 and a one foot overbuild will used for a short distance upstream of this drop structure. Calculations are shown on Plates D-82 to D-83.

47. A settlement analysis using a groundwater drawdown of 8' near Engler and County Highway 17 indicated a possible total consolidation settlement of 3". Comparison of the drawdown curves at the near and far sides of the the structures showed a maximum difference of two feet in the expected drawdown which could lead to a differential settlement of about one inch. Based on this estimate the nearest structures should not be severely impacted. Calculations are shown on Plates D-84 to D-86.

48. Calculations indicated a potential settlement of about 10 inches at the fill being placed for the trail north of Drop Structure 4. An overbuild of 12 inches will be provided. Calculations are shown on Plate D-87.

49. A total settlement profile was developed over the length of the cross-section along the outlet pipe. Settlement calculations used a geologic profile formed by borings 80-33M and 88-98M, which essentially confined settlement to 10 feet below existing grade. A settlement of 7 inches was calculated at the levee centerline, of which 4.5 inches was due to consolidation of a soft clay layer. In order to reduce settlement of the gatewell and outlet pipe to an acceptable level, excavation along the outlet pipe down to elevation 765.0 to remove the compressible layer is planned. An eight inch overbuild will be required from approximately station 58+70 to station 60+00. Calculations are shown on Plates D-88 to D-90.

50. A surcharge was to be placed along the pipe alignment at Outlet D during the 1993 construction season to consolidate soils so the majority of the anticipated settlement would occur prior to construction of the outlet in the Stage 3 construction contract. Due to high water during the 1993 construction season the surcharge was not placed. Outlet D will not be constructed until the surcharge has had adequate time to consolidate the foundation soils. The time required for this will be evaluated when a revised schedule has been furnished by the construction contractor.

51. It is recommended that all levees constructed on clay foundations be allowed some settlement period before final levee grooming and before trails are paved. This will insure required levee freeboards are as designed. The following table summarizes the recommended overbuild for the levees.

Table D-10: Summary of Required Overbuild
Looking Downstream

stationing		
left bank	right bank	overbuild height
6+35 - 8+25	6+65 - 8+25	2'
8+60 - 11+10	8+60 - 11+10	1'
33+21 - 44+00	33+21 - 46+00	3"
	51+86 - 58+00	6"
	58+00 - 60+00	1'
53+00 - 55+00		3"
51+88 - 52+60		1'

FROST

52. The expected depth of frost penetration was taken from the Design Memorandum for the Stage 2 Chaska Project. For unsaturated sands a maximum frost penetration of eight feet is possible, if the sands are saturated the frost will penetrate to a depth of five and one half feet. The drop structures are the most susceptible to frost damage. All the base slabs will be located below the water table and the foundation materials should remain saturated. A minimal amount of excavation will be required to remove frost-susceptible materials from below the base slabs. The base material shall then be tested to insure that less than 6% passes 0.02 mm to insure low to medium frost-susceptible material is present within 5.5 feet of the bottom of the slabs. The base of the retaining wall footings adjacent to the drop structures appear to be below the frost depth. Soil classification has been based on Table 2-1 of TM 5-818-2. The following table indicates minimum excavation at the drop structures required to remove frost-susceptible materials.

Table D-11: Summary of Frost Depth Subcuts

Drop Structure	Boring	Minimum Excavation Depth(elevation)
1	92-198M	707
2	90-136M	709
3	92-199M	738
4	92-171M	750

RIPRAP AND BEDDING

53. Ripraps, beddings, drainage fill, and geotextile have or will be designed using the filter criteria from Appendix D of EM 1110-2-1901 (Change 1). Except for the areas directly downstream of the drop structures a geotextile was used instead of intermediate beddings. In

order to reduce the number of required material types the number of ripraps shown in the Hydraulics Appendix were combined so only 3 types of riprap are required. In areas where the channel invert will be above the existing water table(from station 15+20 to 25+90 where the majority of the soils are granular) a geotextile will be used to filter the existing soils. A 6" layer of pervious fill will be placed above the geotextile to protect the the geotextile during riprap placement. In areas where the channel invert will be below the existing water table and the soils consist of layered sands and clays a drainage fill is provided under the geotextile. Since the drop structures are backfilled with pervious soils a bedding will be used instead of the geotextile to form an inverted filter which should prevent piping of material due to the seepage under the drop structures.

ARTICULATED SLOPE PROTECTION

54. The final geotechnical design of the articulated slope protection remains to be done. The current layout has been based on manufacturers' literature for a typical installation on a well drained and compacted subgrade. It is important to note that a well compacted and drained subgrade cannot be insured where the slope protection will be placed in or under the water. If the the construction contractor tried to place the slope protection when the river level is about elevation 705 then the first 250' of slope protection would have to be placed underwater. It is anticipated that to get heavy equipment in place a 2' overexcavation will be required. This area will be backfilled with granular material to form a working pad. This material will also provide a drained foundation for the area outside of the river. The conceptual design has anchors(duck-billed) installed at 2' o.c. around the perimeter of the slope protection. Interior anchors will be located at 4' o.c. around the perimeter of the interior of each 4' x 16' individual mat. The two foot overexcavation will be filled with 1.5' of pervious material underlain with 6" of filter material. Topsoil and seed or gravel will be required for filling the spaces between the individual blocks. The type of anchor finally chosen needs to be load tested at the construction site. After high flows the city will need to check that the gravel or topsoil and grass has not washed out of the areas between the individual concrete blocks. Loss of the gravel or top soil could lead to degradation of the underlying geotextile.

PARAMETERS FOR STRUCTURAL DESIGN

55. Backfill around concrete structures will include both pervious and impervious fill. The backfill for the gatewells will be impervious material. Pervious drainage material will be used as backfill around the landside one-third of the outlet pipe lengths and impervious material will placed around the riverside two-thirds of the outlet pipes. Below grade backfill for the drop structures will be pervious material. Lateral earth pressure coefficients for backfill material were determined in accordance with guidance presented in EM 1110-2-2502 which essentially requires at-rest pressures be used for design. Pervious fill will extend outward from the base of the foundation slabs at a 45 degree angle to insure the failure plane remains within the pervious fill. A six inch layer of drainage fill will be placed outside the pervious fill at Drop Structures 1,3 and 4 to prevent fines from the adjacent

foundation materials from contaminating the pervious fill. To provide continuity with the impervious levees, above grade fill will be impervious material. The generalized soil parameters used for these materials are tabulated in Table D-12 below.

Table D-12: Generalized Backfill Soil Parameters

Material Type	Unit Weights Moist (pcf)	Unit Weights Saturated (pcf)	Drainage Condition	Shear Strength Cohesion (psf)	Shear Strength Phi (degrees)
Pervious	114	127	All	0	33
Impervious	115	125	Q (U-U)	1000	20
			R (C-U)	500	9
			S (C-D)	0	29.5

Note: The impervious backfill strength was based on material from the Stage 4 borrow area.

LANDSCAPING

56. The final landscaping plan will be developed during the preparation of the plans and specifications. Landscaping will be in compliance with EM 1110-2-301. Plantings will be selected from shallow rooting species. As discussed in the landscaping appendix the majority of roots will only penetrate 18 to 24 inches into the soil. The size and density of the roots which penetrate further than 24 inches has yet to be determined. Because the design flow in the channel and levees will only last a short time(less than a day) it is not anticipated that seepage along plant roots which penetrate further than twentyfour inches would create a problem. The three foot root free zone for this project will be a three foot "mostly" root free zone. It will be assumed that the surface roots develop to the same radius as the crown of the trees, therefore trees should be placed so the roots do not penetrate into the root free zone. If it is desired to place trees that will eventually shade the trail on top of the levees a biobarrier should be placed to keep the roots from the root free zone.

CONSTRUCTION MATERIALS

57. Ample satisfactory pervious material is available in the project area and could be available from the channel excavation. Impervious levee fill material will come from the diversion channel excavation and a borrow area. It is assumed the borrow area used for stage 4 will be used and no additional soil strength testing will be required. Plate D-91 was used in determining usable quantities of materials from the required excavation. Tested and approved concrete aggregate can be obtained within 25 miles of the project site. Acceptable quality riprap can be obtained within 20 miles of the project site.

CONSTRUCTIBILITY CONCERNS

58. Preconstruction surveys should be obtained to assess the conditions of the two buildings near Engler Boulevard and County Highway 17 to determine what damage construction of the new channel will cause. The new Engler Blvd embankment may cause some settlement of the northernmost building. The new Highway 17 and Engler Blvd may also experience some settlement caused by drawdown when the channel is excavated.

59. In the Engler-Highway 17 area, if soil strengths are considerably lower than assumed or the water table is not drawn down as expected it would be possible to stabilize the slopes by the use of trench drains and/or sand or stone columns. The following construction procedure is recommended between stations 33+00 and 60+00:

a. channel is excavated

b. allow one month to determine if slope will remain stable, if the area had been dewatered then dewatering will be stopped at the beginning of this time frame.

c. if slope is not stable, install trench drains

d. place drainage fill, geotextile and riprap

60. Dewatering will be needed at the drop structures and the outlets. NCSPD-ER has determined that there will be no environmental problems or concerns caused by the short term construction dewatering near the fen.

61. Drying out the lime pile may be a problem. Currently the lime is removed in thin lifts after a surface crust has formed, the deep excavation anticipated during this construction may have to be done in stages and by dragline. Borings 92-172M, 92-173M, 92-195M and 92-196M all show the water content of the lime is above the liquid limit. The contract must also have a mechanism to determine where the bottom of the lime pile is so no soil is mixed with the lime.

MISCELLANEOUS

62. Several dams and embankments upstream of the channel inlet are used to limit the flows to the channel. A complete listing is shown in the Hydrology Appendix. The St. Paul District has determined that these structures do not have to be reviewed to determine if they meet COE criteria. Upstream dams with the exception of Lake Grace Dam do not have any outstanding MNDNR safety concerns. The City of Chaska is currently making improvements to Lake Grace Dam because of concerns mentioned in a 1980 Dam Safety Report. An existing RR embankment will be depended on to pond water, a sketch of the embankment and a boring, 90-142M, through the embankment are shown on Plates D-93 and D-94.

63. The city is designing a new embankment at Highway 41 and East Creek. A new set of culverts will be installed in a widened embankment.

64. The city is designing bridges over the channel at Stoughton Avenue, Engler Boulevard, and at Highway 212.

65. Additional soil borings and testing were done by the city of Chaska for the design of Highway 17 and Engler Boulevard. These boring encountered fairly thick layers of peat along the new highway alignment north of the new intersection of the two roads. The design of the new highway embankment includes a 6' surcharge and a settlement period of 1 year. A very weak clay(unconfined ultimate strength of 108 psf at

approx. 50% strain, 45 psf at approx 12% strain) was found at a depth of 7.5 to 8.5' at the Engler and Highway 17 intersection. It is expected that the road surcharge or embankment will consolidate the material.

FURTHER INVESTIGATIONS AND/OR ANALYSES

66. The items listed below require further investigations or analyses prior to completion of the plans and specifications.

a. The borrow area for impervious fill must be located,sampled and tested unless the stage 4 borrow area is used.

b. The final geotechnical design for the articulated concrete slope protection needs to be completed.

c. Design instrumentation plan for monitoring building settlement near Engler and Highway 17.

d. Selection of geotextiles.

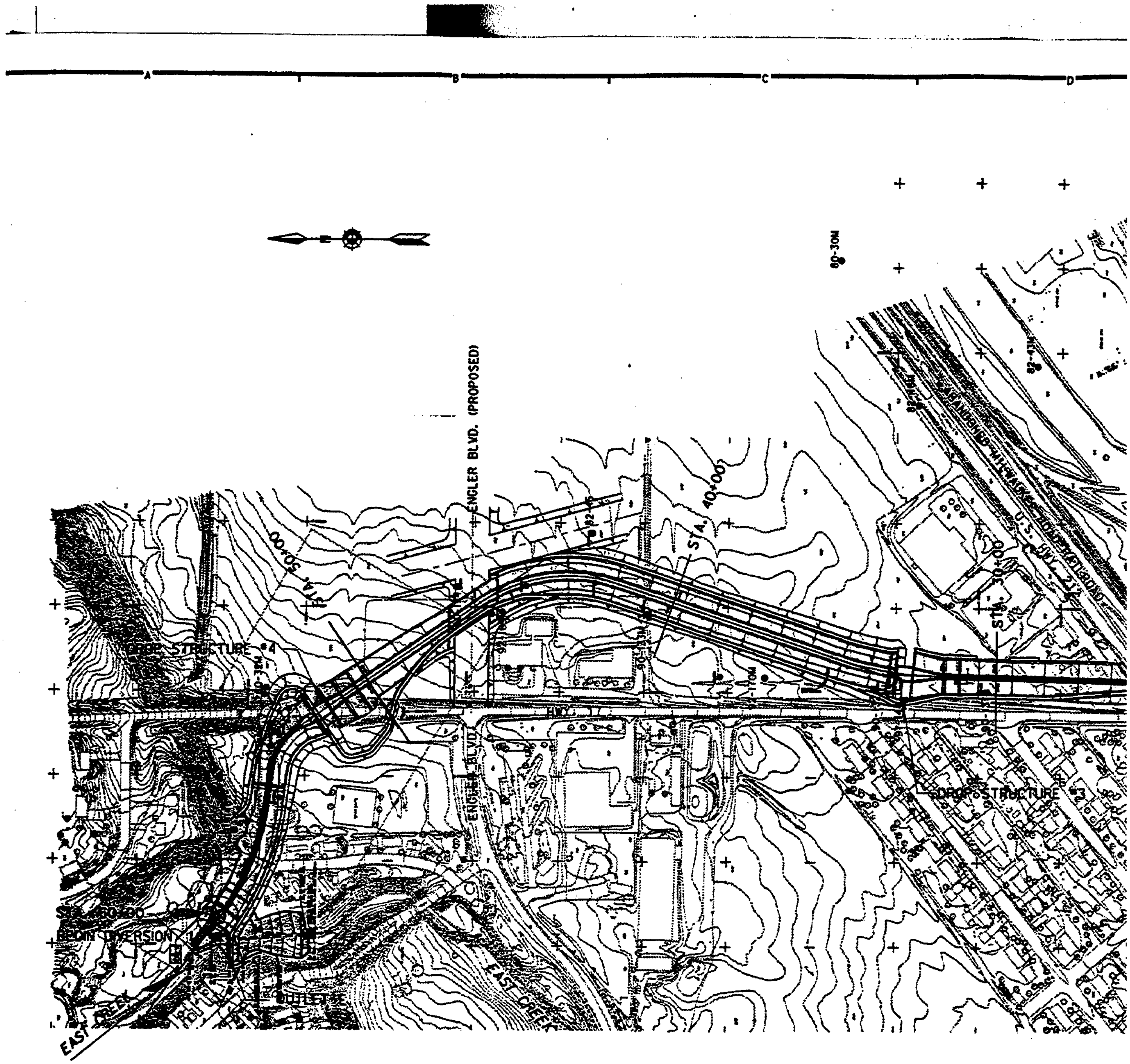
e. Look at the feasibility of using zoning of materials(both random and impervious fill) in levees rather than requiring them to all be impervious.

f. Insure final landscaping plan meets criteria.

g. Determine the plan for stabilizing slopes if required between stations 33+00 and 60+00.

h. Determine a method of providing equivalent uplift protection near station 12+80 where the installation of the toe drain would require relocation of the gas pressure regulating station.

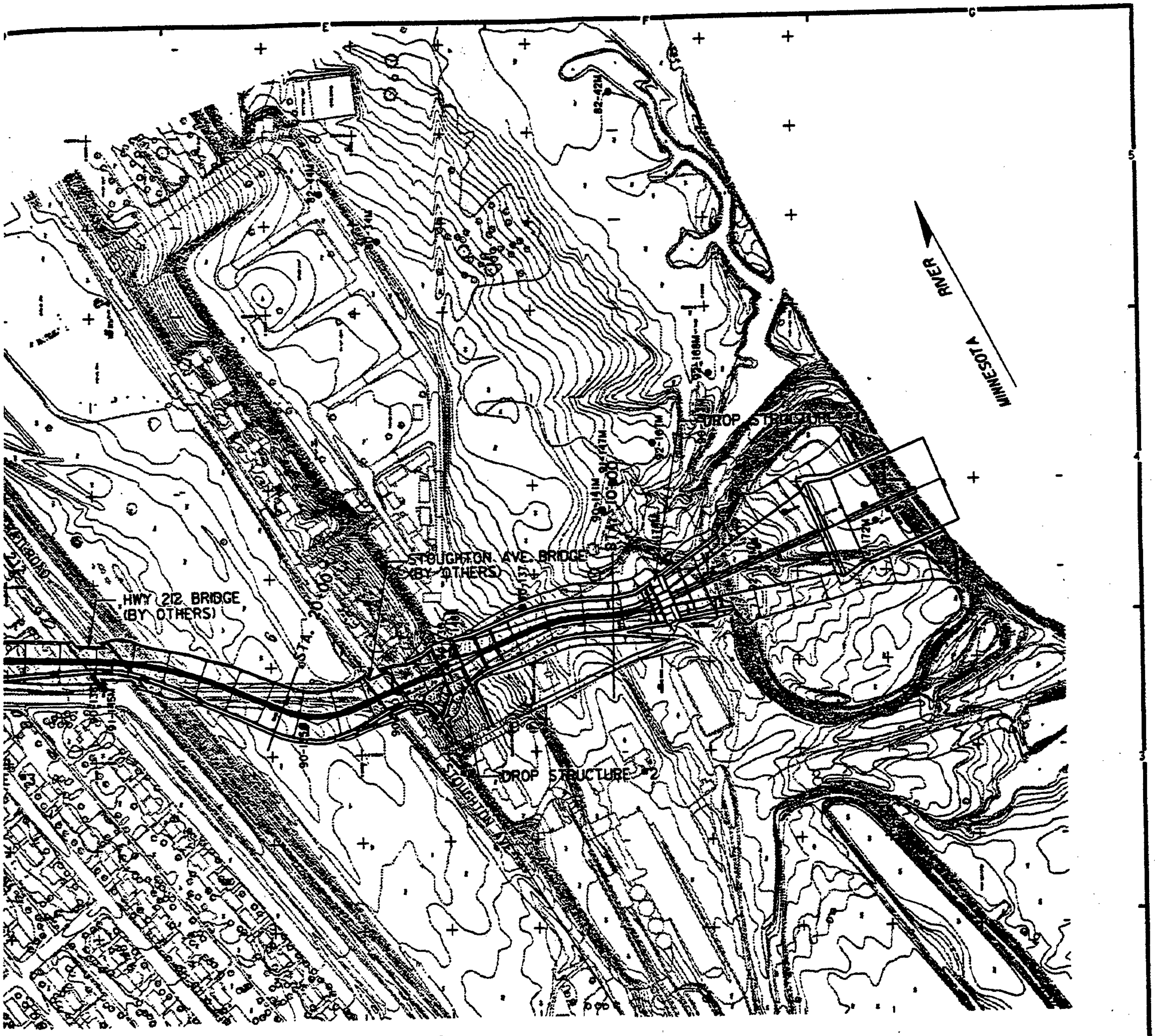
i. If the final material disposal areas(described in Appendix G) are to be located directly adjacent to the channel, additional slope stability and settlement calculations may be required.



GENERAL PLAN

200 0 200 400
SCALE IN FEET

BORING LO



LEGEND	
BORING LOCATION	80-34M

SYMBOL	DESCRIPTION	DATE	APPROVAL

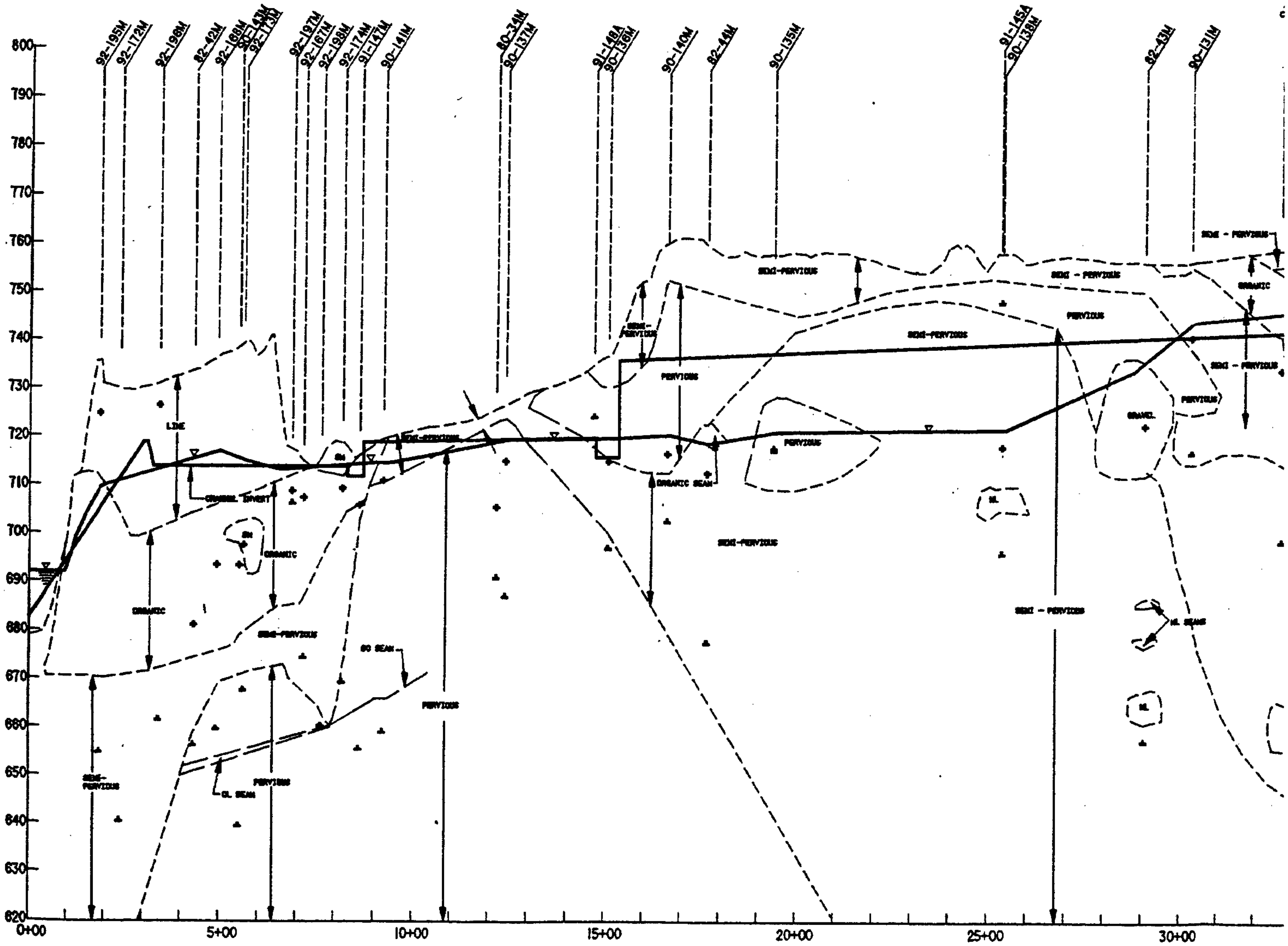
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

DESIGN MEMORANDUM
CHASKA - STAGE 3
FLOOD CONTROL - EAST CREEK
CHASKA PROJECT CHASKA, MINNESOTA
GEOLOGICAL DATA
BORING LOCATIONS NOT SHOWN ON PLAN & PROFILE SHEETS

ED-D	DESIGNED:	
	CHECKED:	
	DRAWN:	TJ
ED-GH	DESIGNED:	JRC
	CHECKED:	JRC

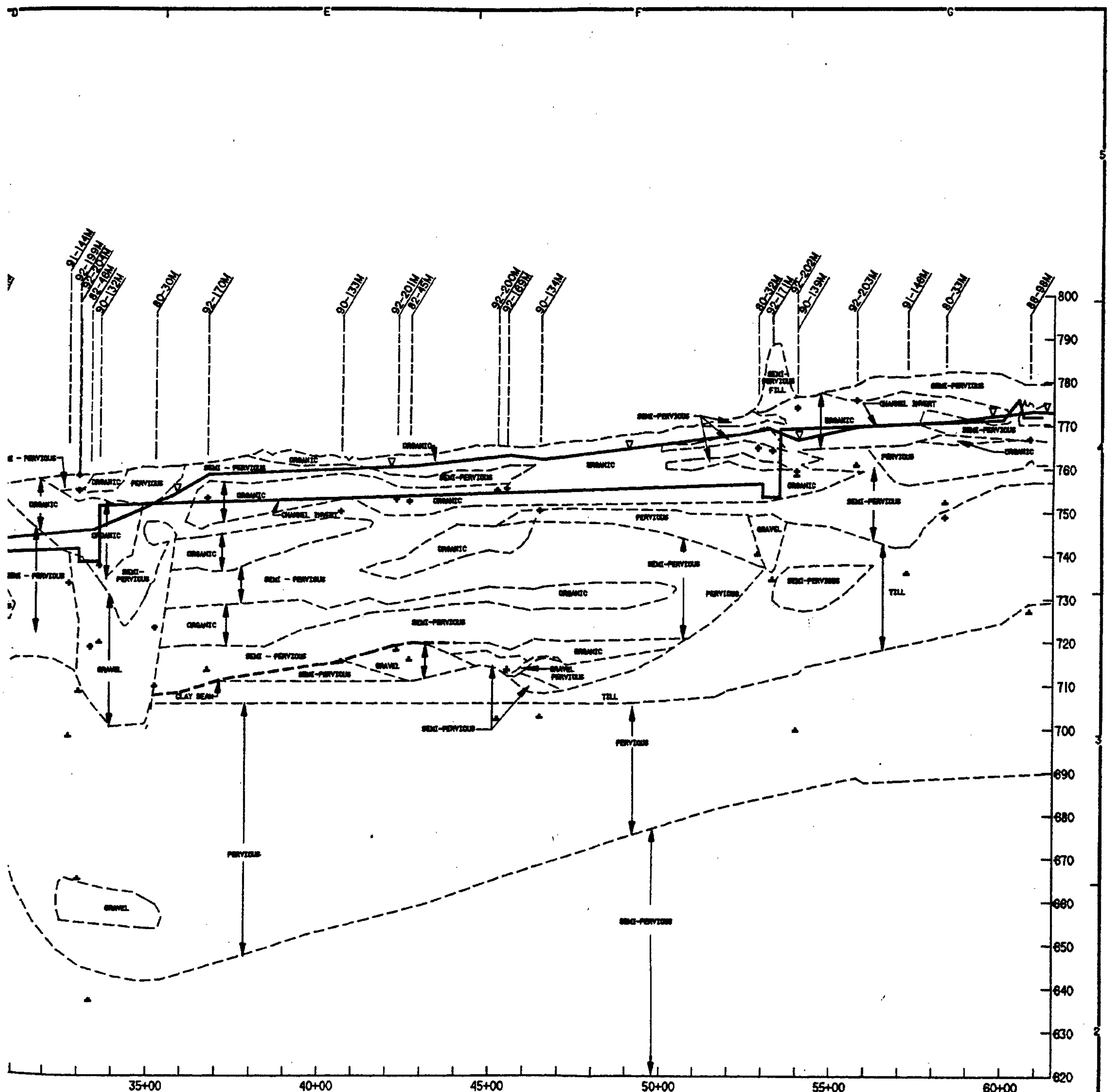
DATE: OCTOBER 1993
CAD FILE NAME: chs3plan.dgn
SPEC NO: DACW37-90-B-0000
DRAWING NUMBER: PLATE D-1
SHT 1 OF 16



PROFI
STATION 0+00 TC

LEGEND:

LIME (FILL)	SUGAR BEET PROCESS RESIDUE CONSISTING OF CALCAREOUS MH CL AND OL.
ORGANIC	FLOOD PLAIN DEPOSITS OF ORGANIC RICH OH, OL, CH, CL, ML, AND Pt. - OCCASIONAL SM AND ML SEAMS.
PERVIOUS	ALLUVIAL DEPOSITS OF GP, GW, AND GRANULAR SP.
TILL	GLACIALLY DERIVED GRAVELLY CLAYS WITH VARYING AMOUNTS OF SAND AND SILT, STIFF TO HARD.
SEMI-PERVIOUS	ALLUVIAL DEPOSITS OF SP-SM, SM, AND GM.
✦	INDICATES BOTTOM OF SAMPLER WHEN WATER LEVEL OBTAINED.
▲	INDICATES BOTTOM OF BORING.



PROFILE
0+00 TO STATION 6I+50

CL AND OL.
, AND
OF SAND

NOTES:

1. GEOLOGIC PROFILE BASED ON EARLY ALIGNMENT. APPROXIMATE LOCATIONS OF STRUCTURES ARE SHOWN.
2. ELEVATION AND STATIONING IN FEET.
3. SPECIFIC INFORMATION REGARDING INDIVIDUAL BORINGS IS CONTAINED ON THE BORING LOGS PLATES.

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

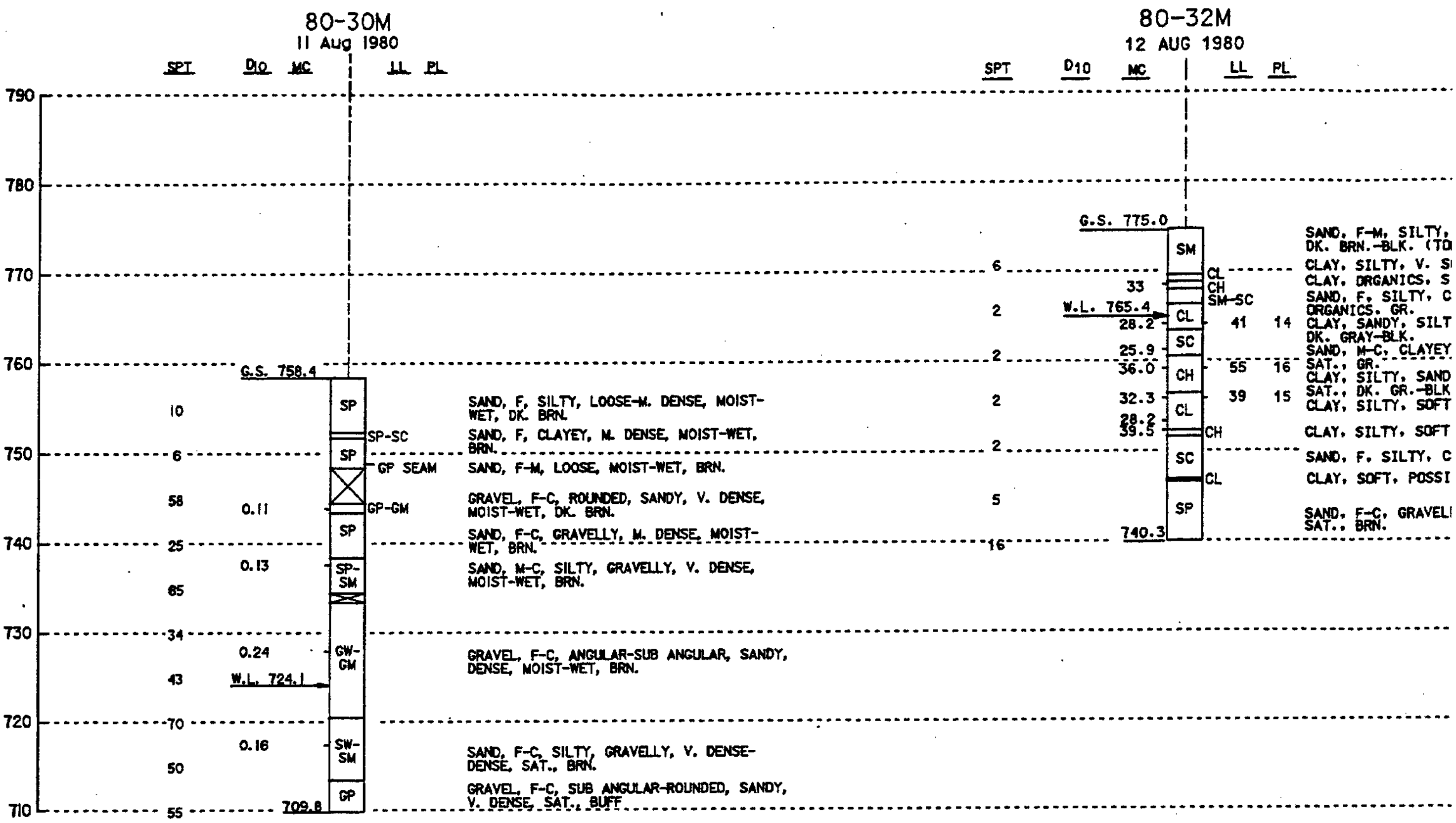
DESIGN MEMORANDUM
CHASKA - STAGE 3
FLOOD CONTROL - EAST CREEK
CHASKA PROJECT CHASKA, MINNESOTA

GEOLOGICAL DATA
GEOLOGIC PROFILE
STATION 0+00 TO STATION 6I+50

DESIGNED:
CHECKED:
DRAWN:
DESIGNED: LJL/PAW
CHECKED: CWB/JRC
DATE: OCTOBER 1993

CAD FILE NAME: che3pro4.dgn
SPEC NO: DACW37-90-B-0000
DRAWING NUMBER: PLATE D-2
SHT 2 OF 16

2



NOTES

1. WATER LEVEL DETERMINED AFTER UNKNOWN AMOUNT OF TIME WITH BOTTOM OF HOLLOW STEM AUGER SET TO EL. 728.4' AND SAMPLER DRIVEN TO EL. 723.4'.
2. HSA ADVANCED TO EL. 714.4'. HOLE STABILIZED WITH DRILLING MUD BELOW EL. 714.4'.
3. CASING WAS PULLED AND HOLE BACKFILLED WITH NATIVE SOILS AND CEMENT.

NOTES:

1. WATER LEVEL DETERMINED AFTER UNKNOWN AMOUNT TIME WITH HOLLOW STEM AUGER SET TO EL. 770.0 SAMPLER DRIVEN TO EL. 765.0.
2. HOLLOW STEM AUGER WAS SET FROM EL. 775.0 TO 745.0. SAMPLER WAS DRIVEN TO EL. 740.3.
3. CASING WAS PULLED AND HOLE BACKFILLED WITH N SOILS.

GENERAL BORING LEGEND

84-1M	YEAR OF BORING-BORING NUMBER, BORING TYPE (EG: M=MACHINE, A=AUGER, TP=TEST PIT, P=PIEZOMETER).
1 MAY 1984	DATE OF BORING
G.S. 1020.2	GROUND SURFACE ELEVATION AT BORING
GW	WELL GRADED GRAVELS, GRAVEL - SAND MIXTURE, LITTLE OR NO FINES
GP	POORLY GRADED GRAVELS, LITTLE OR NO FINES
GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
SW	WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
SP	POORLY GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
SM	SILTY SANDS, SAND - SILT MIXTURES
SC	CLAYEY SANDS, SAND - CLAY MIXTURES
ML	INORGANIC SILTS, LIQUID LIMIT LESS THAN 50
MH	INORGANIC SILTS, LIQUID LIMIT GREATER THAN 50
CL	INORGANIC CLAYS, LOW TO MEDIUM PLASTICITY, LIQUID LIMIT LESS THAN 50
CH	INORGANIC CLAYS, HIGH PLASTICITY, LIQUID LIMIT GREATER THAN 50
OL	ORGANIC SILTS OR CLAYS, LOW PLASTICITY, LIQUID LIMIT LESS THAN 50
OH	ORGANIC SILTS OR CLAYS, MEDIUM TO HIGH PLASTICITY, LIQUID LIMIT GREATER THAN 50
PT	PEAT
SP-SM	BORDERLINE MATERIAL
SP& SM	STRATIFIED MATERIAL
1	LOCATION AND SAMPLE NUMBER FOR UNDISTURBED SAMPLE
	NO RECOVERY
W.L. 726.7	WATER LEVEL ON DATE OF BORING
700	ELEVATION AT BOTTOM OF BORING

GENERAL BORING NOTES

1. GENERAL :	THE UNIFIED SOIL CLASSIFICATION SYS' REPRESENTS ONLY THE BASIC SOILS. 1 IS ADDED TO THE RIGHT OF THE BORI SHOWN BELOW THE BORING STAFF. THE ON THE ORIGINAL FIELD LOGS. THESE L DISTRICT OFFICE. ARRANGEMENTS TO I
2. MOISTURE CONTENT:	THE NATURAL MOISTURE CONTENT IN I THE BORING STAFF.
3. BLOW COUNT (SPT):	BLOW COUNTS ARE SHOWN TO THE LE OF BLOWS NECESSARY TO DRIVE THE ARE FOR A STANDARD PENETRATION 1 DROP. FOR NON-STANDARD BLOW COUN ARE AS SHOWN. WT SIGNIFIES PENETRA WITHOUT DRIVING THE SAMPLER UNDEF CONSISTENCIES GREATER THAN WT BU
4. ATTERBERG LIMITS:	LIQUID LIMIT (LL) AND PLASTIC LIMIT
5. D_{10} SIZE:	THE GRAIN SIZE IN MILLIMETERS OF W OF THE BORING STAFF.

C D E F

80-32M

12 AUG 1980

SPT	D10	MC		LL	PL	
		G.S. 775.0	SM			SAND, F-M, SILTY, GRAVELLY, LOOSE, MOIST, DK. BRN.-BLK. (TOPSOIL)
6			CL			CLAY, SILTY, V. SOFT-SOFT, WET, RED-BRN.
		33	CH			CLAY, ORGANICS, SILTY, SOFT, SAT., BLK.-GR.
			SM-SC			SAND, F, SILTY, CLAYEY, LOOSE, SAT., ORGANICS, GR.
2		W.L. 765.4 28.2	CL	41	14	CLAY, SANDY, SILTY, SOFT, SAT., ORGANICS, DK. GRAY-BLK.
2		25.9	SC			SAND, M-C, CLAYEY, GRAVELLY, LOOSE, SAT., GR.
		36.0	CH	55	16	CLAY, SILTY, SANDY, ORGANICS, SOFT, SAT., DK. GR.-BLK.
2		32.3	CL	39	15	CLAY, SILTY, SOFT, SAT., BUFF-BRN.
		28.2 39.5	CH			CLAY, SILTY, SOFT, SAT., BRN.
2			SC			SAND, F, SILTY, CLAYEY, LOOSE, SAT.
			CL			CLAY, SOFT, POSSIBLE ARTESIAN PRESSURE
5			SP			SAND, F-C, GRAVELLY, LOOSE-M. DENSE, SAT., BRN.
16		740.3				

NOTES:

1. WATER LEVEL DETERMINED AFTER UNKNOWN AMOUNT OF TIME WITH HOLLOW STEM AUGER SET TO EL. 770.0 AND SAMPLER DRIVEN TO EL. 765.0.
2. HOLLOW STEM AUGER WAS SET FROM EL. 775.0 TO EL. 745.0. SAMPLER WAS DRIVEN TO EL. 740.3.
3. CASING WAS PULLED AND HOLE BACKFILLED WITH NATIVE SOILS.

80-33M

13 AUG 1980

SPT	D10	MC		LL	PL
		G.S. 782.0	SP-SC		
26			SM		
		22.3	CL	28	15
6		W.L. 770.6 26.0	SC		
3/2'	0.088		SW-SM		
		35.9	CL	47	15
2	0.23		SP		
			SP-SM		
			GP		
12			SP		
			GP		
9	0.17	752.3	SP-SM		

NOTES:

1. WATER LEVEL DETERMINED AFT TIME WITH HOLLOW STEM AUGE SAMPLER DRIVEN TO EL. 769.
2. HOLLOW STEM AUGER WAS SET 757.0. SAMPLER WAS DRIVEN

E, MOIST-

IST-WET,

BRN.

V. DENSE,

, MOIST-

. DENSE,

LAR, SANDY,

DENSE-

DED, SANDY,

: OR NO FINES

NES

) FINES

MIT LESS THAN 50

: THAN 50

LESS THAN 50

JQUID LIMIT

LE

GENERAL BORING NOTES

1. GENERAL : THE UNIFIED SOIL CLASSIFICATION SYSTEM IS USED TO IDENTIFY BASIC SOIL TYPE. THE LEGEND REPRESENTS ONLY THE BASIC SOILS. TO COMPLETE THE CLASSIFICATION, PERTINENT INFORMATION IS ADDED TO THE RIGHT OF THE BORING STAFF. NOTES PERTAINING TO A SPECIFIC BORING ARE SHOWN BELOW THE BORING STAFF. THE BORINGS SHOW SUMMARIES OF INFORMATION RECORDED ON THE ORIGINAL FIELD LOGS. THESE LOGS ARE AVAILABLE FOR INSPECTION AT THE ST. PAUL DISTRICT OFFICE. ARRANGEMENTS TO INSPECT THE LOGS CAN BE MADE BY CALLING (612) 220-0599.
2. MOISTURE CONTENT: THE NATURAL MOISTURE CONTENT IN PERCENT OF DRY WEIGHT (MC) IS SHOWN TO THE LEFT OF THE BORING STAFF.
3. BLOW COUNT (SPT): BLOW COUNTS ARE SHOWN TO THE LEFT OF THE BORING STAFF AND, EXCEPT AS NOTED, ARE THE NUMBER OF BLOWS NECESSARY TO DRIVE THE SAMPLER USED A DISTANCE OF 12". STANDARD BLOW COUNTS ARE FOR A STANDARD PENETRATION TEST (SPT) USING A 1-3/8" X 2" SAMPLER, 140 LB. HAMMER AND A 30" DROP. FOR NON-STANDARD BLOW COUNTS, SAMPLER SIZE, HAMMER WEIGHT AND HEIGHT OF DROP ARE AS SHOWN. WT SIGNIFIES PENETRATION UNDER THE CUMULATIVE WEIGHT OF SAMPLING TOOLS WITHOUT DRIVING THE SAMPLER UNDER SPT CONDITIONS. SPT VALUES OF 0 DEFINE DENSITIES AND CONSISTENCIES GREATER THAN WT BUT LESS THAN ONE BLOW PER FOOT.
4. ATTERBERG LIMITS: LIQUID LIMIT (LL) AND PLASTIC LIMIT (PL) ARE SHOWN TO THE RIGHT OF THE BORING STAFF.
5. D_{10} SIZE: THE GRAIN SIZE IN MILLIMETERS OF WHICH 10% OF THE SAMPLE IS FINER IS SHOWN TO THE LEFT OF THE BORING STAFF.

SYMBOL

AE APPRO

DESIGN

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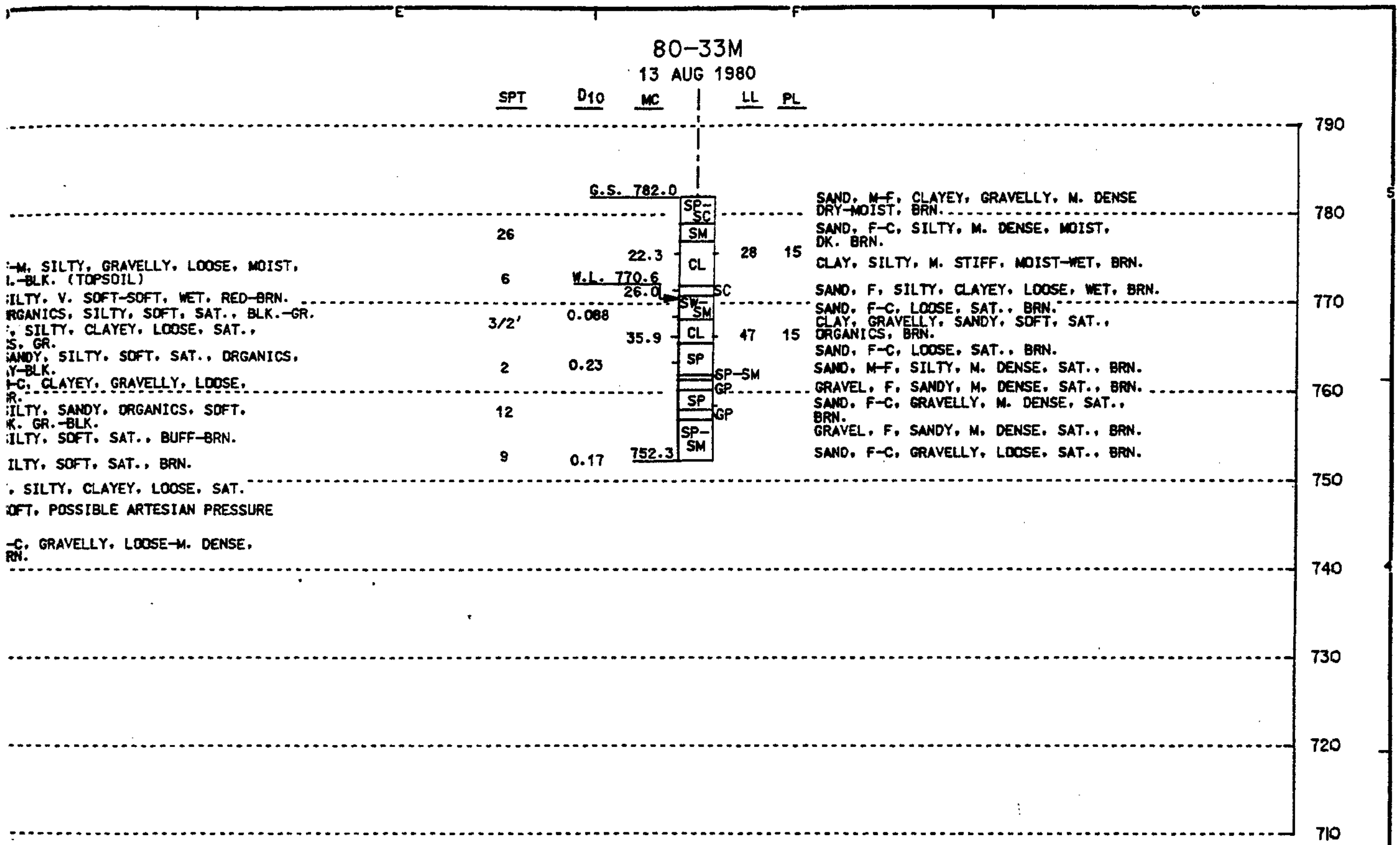
DRAWN

DESIGN

CHECKE

DATE: OCT

C D E



NOTES:

1. WATER LEVEL DETERMINED AFTER UNKNOWN AMOUNT OF TIME WITH HOLLOW STEM AUGER SET TO EL. 772.0 AND SAMPLER DRIVEN TO EL. 769.0.
2. HOLLOW STEM AUGER WAS SET FROM EL. 782.0 TO EL. 757.0. SAMPLER WAS DRIVEN TO EL. 752.3.

WN AMOUNT OF
EL. 770.0 AND

775.0 TO EL.
40.3.
LED WITH NATIVE

CATION SYSTEM IS USED TO IDENTIFY BASIC SOIL TYPE. THE LEGEND
SIC SOILS. TO COMPLETE THE CLASSIFICATION, PERTINENT INFORMATION
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TO THE LEFT OF THE BORING STAFF AND, EXCEPT AS NOTED, ARE THE NUMBER
DRIVE THE SAMPLER USED A DISTANCE OF 12". STANDARD BLOW COUNTS
ETRATION TEST (SPT) USING A 1-3/8" X 2" SAMPLER, 140 LB. HAMMER AND A 30"
BLOW COUNTS, SAMPLER SIZE, HAMMER WEIGHT AND HEIGHT OF DROP
ES PENETRATION UNDER THE CUMULATIVE WEIGHT OF SAMPLING TOOLS
PLER UNDER SPT CONDITIONS. SPT VALUES OF 0 DEFINE DENSITIES AND
HAN WT BUT LESS THAN ONE BLOW PER FOOT.

ASTIC LIMIT (PL) ARE SHOWN TO THE RIGHT OF THE BORING STAFF.

TERS OF WHICH 10% OF THE SAMPLE IS FINER IS SHOWN TO THE LEFT

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

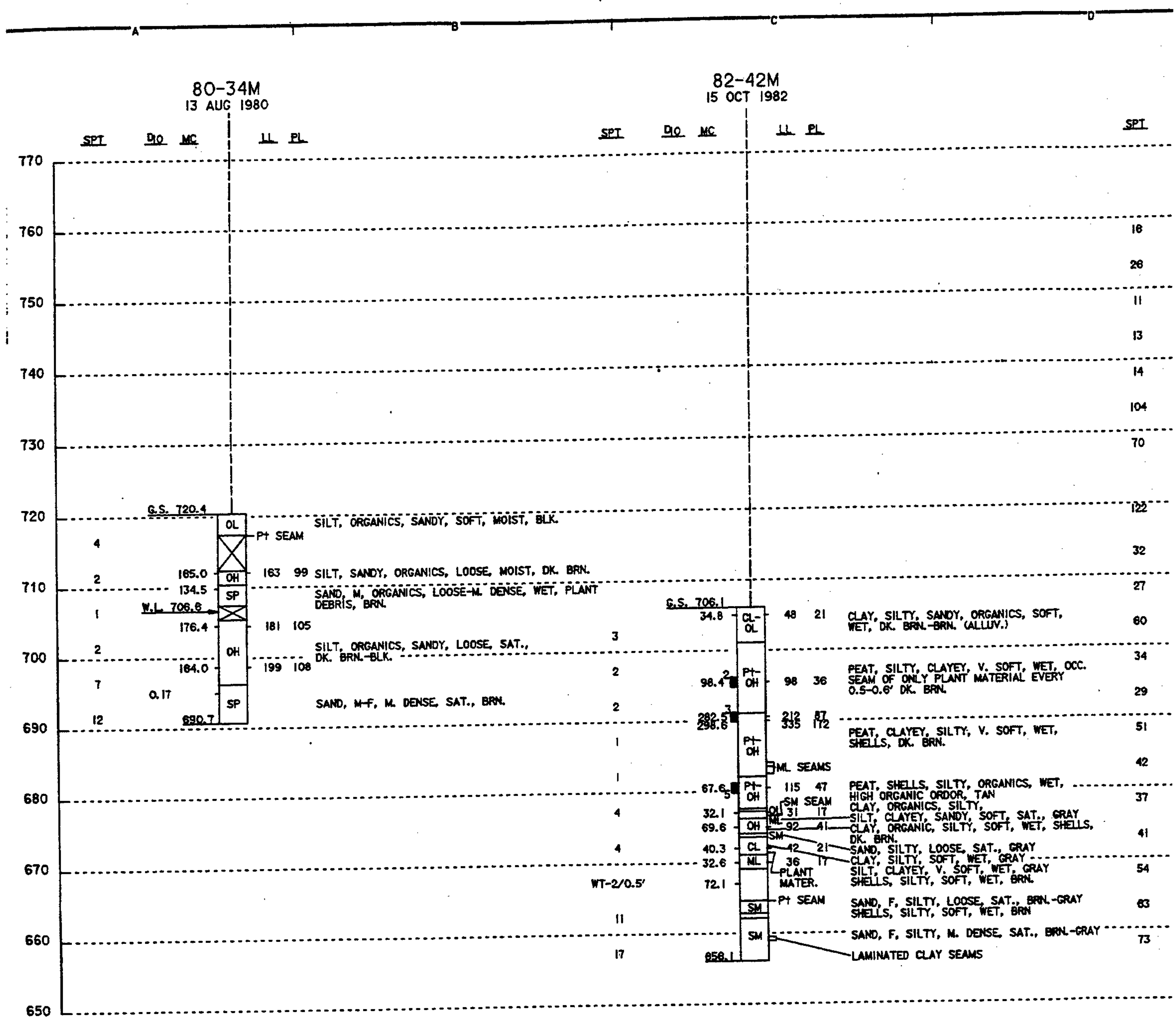
DESIGNED:
CHECKED:
DRAWN:
DESIGNED: LJL/PAW
CHECKED: CWB/JPC
DATE: OCTOBER 1993

DESIGN MEMORANDUM
CHASKA - STAGE 3
FLOOD CONTROL - EAST CREEK
CHASKA PROJECT — CHASKA, MINNESOTA

GEOLOGICAL DATA
BORING LOGS
80-30M AND 80-32M THRU 80-33M

CAD FILE NAME: cha3ah00.dgn
SPEC NO: DACW37-90-B-0000
DRAWING NUMBER: PLATE D-3
SHT 3 OF 16

3



NOTES

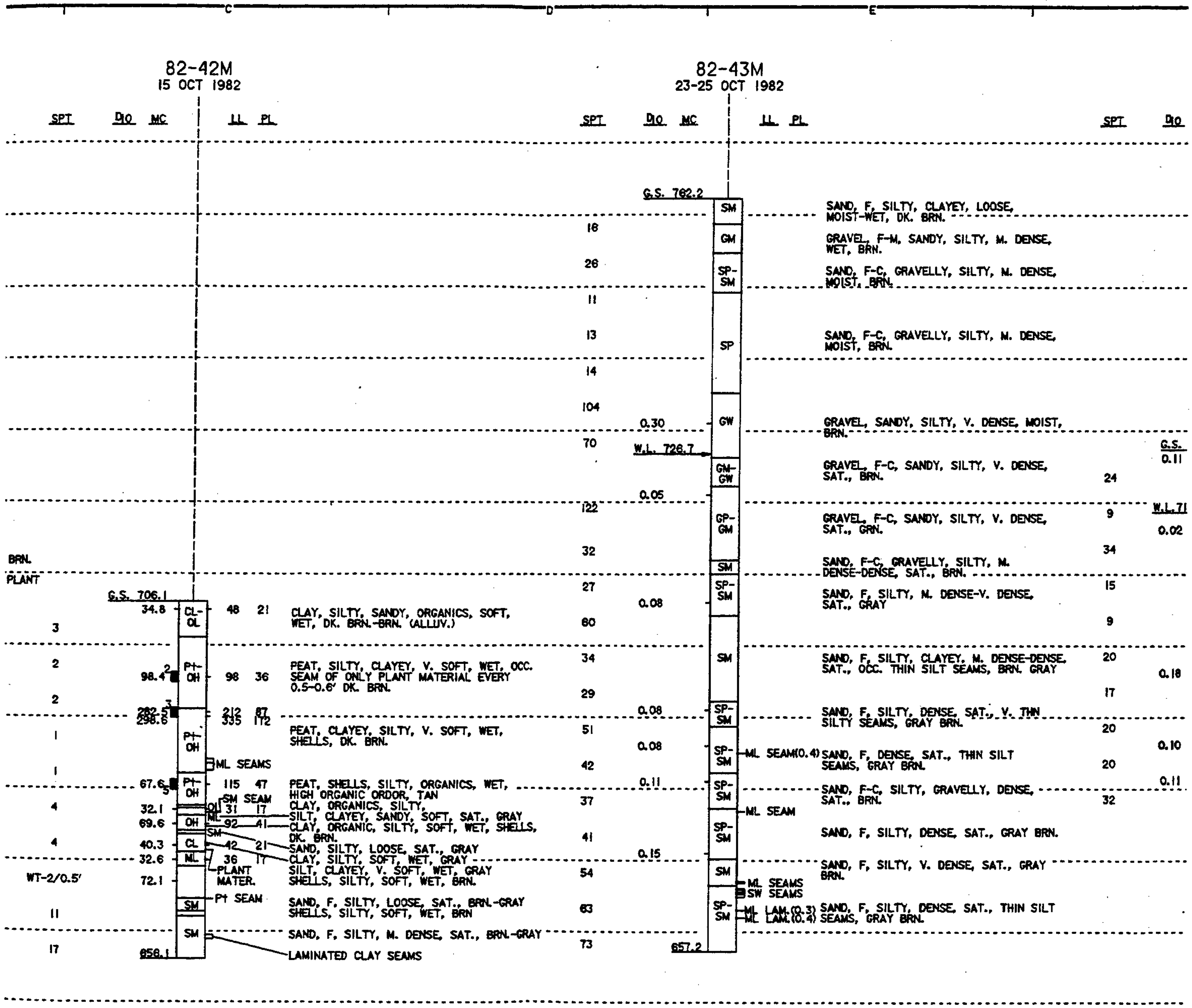
1. WATER LEVEL DETERMINED AFTER UNKNOWN AMOUNT OF TIME WITH BOTTOM OF HOLLOW STEM AUGER SET TO EL. 713.4' AND SAMPLER DRIVEN TO EL. 705.4'.
2. HAS ADVANCED TO EL. 695.4.
3. CASING PULLED AND HOLE BACKFILLED WITH LOCAL SOILS.

NOTES

1. ARTESIAN FLOW CONDITIONS ENCOUNTERED AFTER SAMPLING TO EL. 681.1' AND BOTTOM OF HSA SET TO EL. 686.1'. WATER FLOWED SLOWLY FROM CASING STICK-UP OF 2.0' (EL. 708.1')
2. FIVE 5" UNDISTURBED SHELBY SAMPLES TAKEN FROM THE PILOT BORING. NO OFFSET HOLE WAS DRILLED.
3. HSA ADVANCED TO EL. 661.1'.

NOTES

1. W
2. H
3. C



NOTES

1. ARTESIAN FLOW CONDITIONS ENCOUNTERED AFTER SAMPLING TO EL. 681.1' AND BOTTOM OF HSA SET TO EL. 686.1'. WATER FLOWED SLOWLY FROM CASING STICK-UP OF 2.0' (EL. 708.1')
2. FIVE 5" UNDISTURBED SHELBY SAMPLES TAKEN FROM THE PILOT BORING. NO OFFSET HOLE WAS DRILLED.
3. HSA ADVANCED TO EL. 661.1'.

NOTES

1. WATER LEVEL DETERMINED AFTER 15 MINUTES WITH BOTTOM OF HSA AT EL. 727.2', AFTER SAMPLING TO EL. 722.2.
2. HSA ADVANCED TO EL. 718.2'. HOLE STABILIZED WITH DRILLING MUD BELOW EL. 718.2', HEAVING SANDS ENCOUNTERED BELOW EL. 707.2'. HSA RESET TO EL. 702.2'. HOLE STABILIZED WITH DRILLING MUD BELOW EL. 702.2'.
3. CASING WAS PULLED AND HOLE WAS ALLOWED TO CAVE IN. TOP OF HOLE CAPPED WITH CEMENT.

NOTES

1. WATER LEVI STEM AUGE
2. HOLE STAB
3. TWO 5" UN
4. CASING WA CEMENT.

SYMBOL

AE APPR

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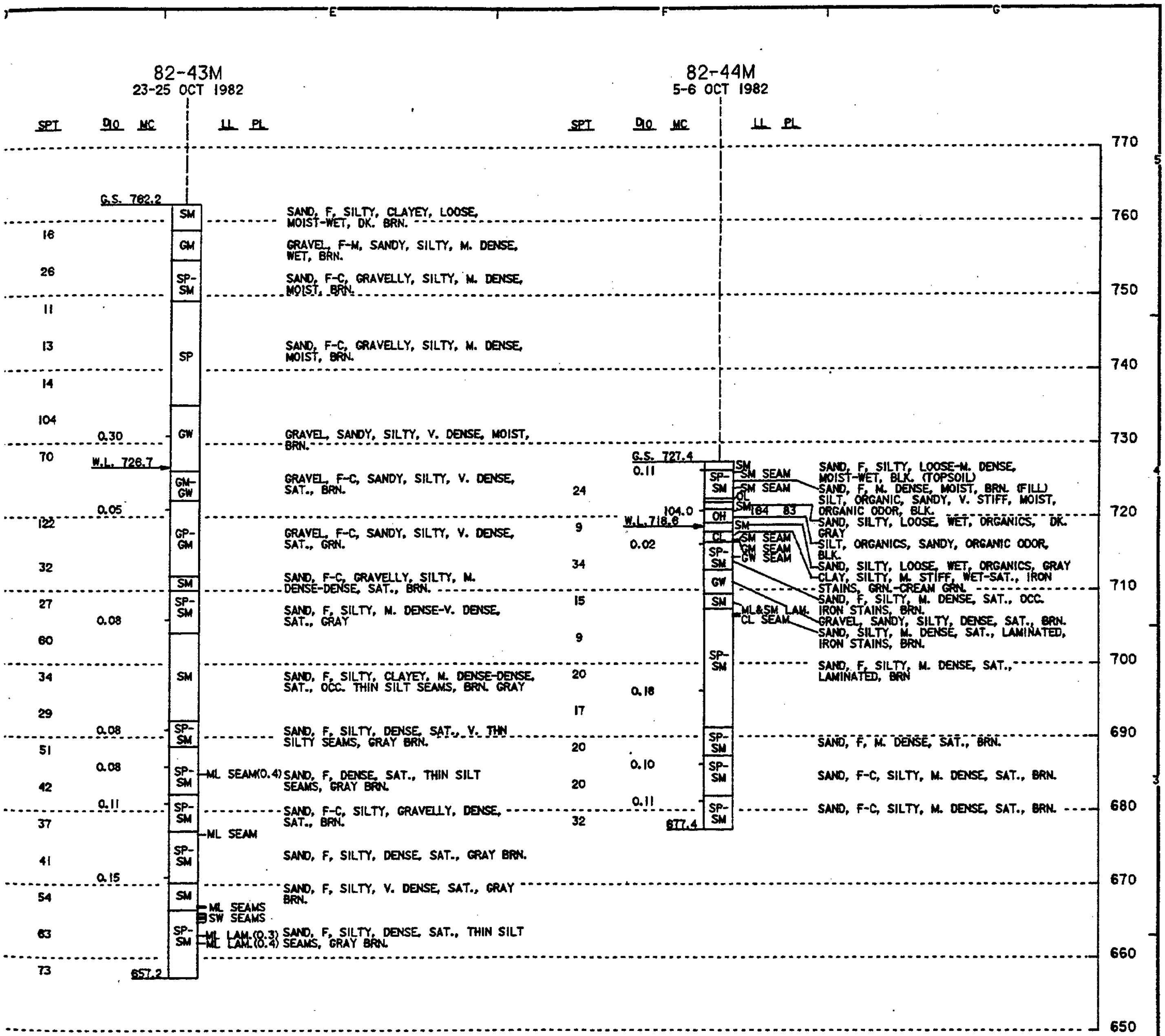
DATE: OC



NOTES

1. WATER LEVEL DETERMINED AFTER 15 MINUTES WITH BOTTOM OF HSA AT EL. 727.2', AFTER SAMPLING TO EL. 722.2.
2. HSA ADVANCED TO EL. 718.2'. HOLE STABILIZED WITH DRILLING MUD BELOW EL. 718.2', HEAVING SANDS ENCOUNTERED BELOW EL. 707.2'. HSA RESET TO EL. 702.2'. HOLE STABILIZED WITH DRILLING MUD BELOW EL. 702.2'.
3. CASING WAS PULLED AND HOLE WAS ALLOWED TO CAVE IN. TOP OF HOLE CAPPED WITH CEMENT.

NOTES

1. WATER LEVEL DETERMINED AFTER 50 MINUTES WITH BOTTOM OF HOLLOW STEM AUGER AT EL. 717.4' AND SAMPLER DRIVEN TO EL. 712.4'.
2. HOLE STABILIZED WITH DRILLING MUD BELOW EL. 717.4'.
3. TWO 5" UNDISTURBED SHELBY SAMPLES TAKEN FROM AN OFFSET HOLE.
4. CASING WAS PULLED AND HOLE BACKFILLED WITH NATIVE SOILS AND CEMENT.

SYMBOL	DESCRIPTION	DATE	APPROVAL

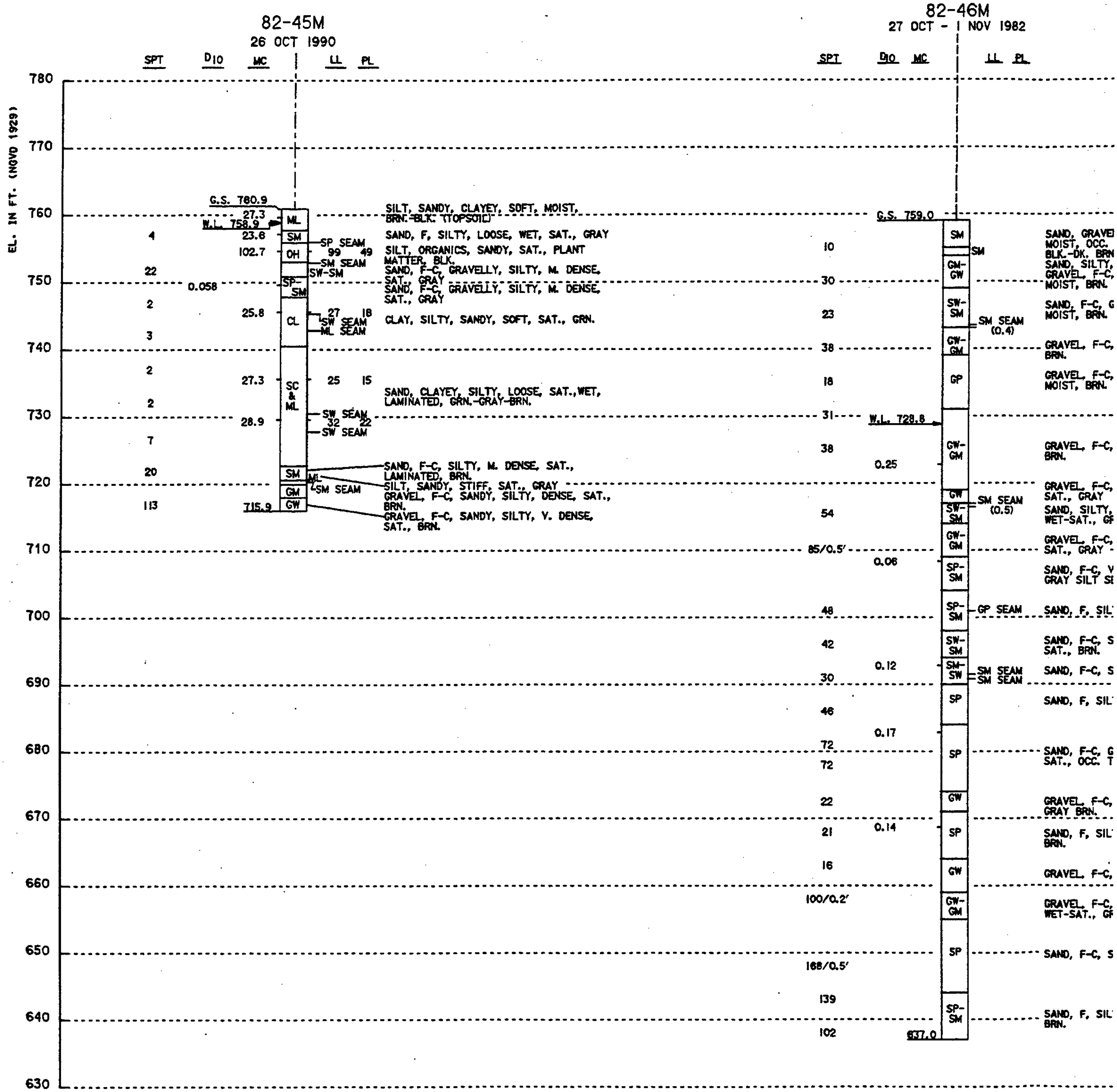
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

DESIGN MEMORANDUM
CHASKA - STAGE 3
FLOOD CONTROL - EAST CREEK
CHASKA PROJECT CHASKA, MINNESOTA

GEOLOGICAL DATA
BORING LOGS
80-34M AND 82-42M THRU 82-44M

DESIGNED:
CHECKED:
DRAWN:
DESIGNED: LJL/PAW
CHECKED: CWB/JRC
CAD FILE NAME: CHS3SHOLDGN
DRAWING NUMBER: PLATE D-4
SHT 4 OF 16
DATE: OCTOBER 1993
SPEC NO: DACW37-90-B-0000



NOTES:

1. WATER LEVEL DETERMINED AFTER 1 HR 30 MIN. WITH HOLLOW STEM AUGER SET AT EL. 755.9 AND SAMPLER DRIVEN TO EL. 752.9.
2. HOLLOW STEM AUGER WAS SET FROM EL. 760.9 TO EL. 755.9. DRILLING MUD WAS USED TO STABILIZE HOLE TO EL. 720.9. SAMPLER WAS DRIVEN TO EL. 715.9.
3. CASING WAS PULLED AND HOLE BACKFILLED WITH CEMENT GROUT.

NOTES

1. WATER LEVEL DETERMINED AFTER APPOXIMATELY 17 OF HOLLOW STEM AUGER SET TO EL. 724.0 AND S EL. 719.0'.
2. HSA ADVANCED TO EL. 690.0' DUE TO WATER LOGS BETWEEN EL. 714.0' AND EL. 684.0'. HOLE STABIL DRILLING MUD BELOW EL. 690.0.
3. DRILLER NOTED ROUGH DRILLING ACTION BETWEEN E EL. 654.0'.
4. CASING WAS PULLED AND HOLE BACKFILLED WITH N

(i)

88-98M
11 APR 1988

SPT	D10	MC	Symbol	LL	PL	Description	Elev.
							780
		G.S. 776.9	SP-SM			SAND, F, SILTY, LOOSE, MOIST, PLANT MATTER, LT. BRN.	
14		W.L. 773.1	SP			SAND, M-F, GRAVELLY, M. DENSE, WET-SAT., BRN.	
							770
4	0.12		SP-SM			SAND, M-F, SILTY, GRAVELLY, LOOSE, SAT., BRN.	
4			SP			SAND, M-F, GRAVELLY, LOOSE, SAT., BRN.	
			SM			SAND, M-F, GRAVELLY, SILTY, M. DENSE, SAT., GR.-BRN.	760
12		10.5	CL	22	10	CLAY, SANDY, GRAVELLY, M. STIFF, WET, BRN. (TILL)	
20			CL			CLAY, SANDY, GRAVELLY, V. STIFF-HARD, WET, GR. (TILL)	750
36			CL			CLAY, SANDY, GRAVELLY, V. STIFF, WET, BRN. (TILL) SP SEAM	
19			CL			CLAY, SANDY, GRAVELLY, V. STIFF, WET, GR. (TILL)	
		9.0	ML	16	13	SILT, CLAYEY, SANDY, GRAVELLY, V STIFF, WET, GR. (TILL)	740
16							
26			CL			CLAY, SANDY, GRAVELLY, V. STIFF, WET, GR. (TILL)	
							730
8		726.9	SP			SAND, F, GRAVELLY, CLAYEY, LOOSE, SAT., BRN.	
							720
							710

NOTES:

1. WATER LEVEL DETERMINED AFTER 60 MIN. WITH HOLLOW STEM AUGER SET TO EL. 771.9, SAMPLER DRVEN TO EL. 766.9, AND HOLE OPEN TO EL. 771.7.
2. HOLLOW STEM AUGER WAS SET FROM EL. 776.9 TO EL. 768.4. DRILLING MUD WAS USED TO STABILIZE HOLE FROM EL. 768.4 TO EL. 731.9. SAMPLER WAS DRIVEN TO EL. 726.9.
3. CASING WAS PULLED AND HOLE FILLED WITH NATURAL SOILS. TOP OF HOLE FILLED WITH 30 LBS PORTLAND CEMENT.

;AND, GRAVELLY, CLAYEY, SILTY, LOOSE, IOIST, OCC. THIN CLAY AND SILT SEAMS, ILK.-DK. BRN. (TOPSOIL)
;AND, SILTY, M. DENSE, MOIST, BRN.
RAVEL, F-C, SANDY, SILTY, M. DENSE, IOIST, BRN.
;AND, F-C, GRAVELLY, SILTY, M. DENSE, IOIST, BRN.
RAVEL, F-C, SANDY, SILTY, DENSE, MOIST, RN.
RAVEL, F-C, SANDY, SILTY, M. DENSE, IOIST, BRN.
RAVEL, F-C, SANDY, SILTY, DENSE, SAT., RN.
RAVEL, F-C, SANDY, SILTY, V. DENSE, AT., GRAY
AND, SILTY, GRAVELLY, V. DENSE, ET-SAT., GRAY
RAVEL, F-C, SANDY, SILTY, V. DENSE, AT., GRAY
AND, F-C, V. DENSE, SAT., OCC. DK. RAY SILT SEAM, GRN.
AND, F, SILTY, DENSE, SAT., GRAY BRN.
AND, F-C, SILTY, GRAVELLY, DENSE, AT., BRN.
AND, F-C, SILTY, DENSE, SAT., BRN.
AND, F, SILTY, DENSE, SAT., GRAY BRN.
AND, F-C, GRAVELLY, SILTY, V. DENSE, AT., OCC. THIN SM SEAMS, GRAY BRN.
RAVEL, F-C, SANDY, M. DENSE, SAT., RAY BRN.
AND, F, SILTY, M. DENSE, SAT., GRAY RN.
RAVEL, F-C, SANDY,M. DENSE, SAT., GRAY
RAVEL, F-C, SANDY, SILTY, V. DENSE, ET-SAT., GRAY
AND, F-C, SILTY, V. DENSE, SAT., GRAY
AND, F, SILTY, V. DENSE, SAT., GRAY RN.

IMATELY 17 HRS. WITH BOTTOM
4.0 AND SAMPLER DRIVEN TO

VATER LOGS ENCOUNTERED
LE STABILIZED WITH

BETWEEN EL. 664.0' AND

ED WITH NEAT CEMENT.

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

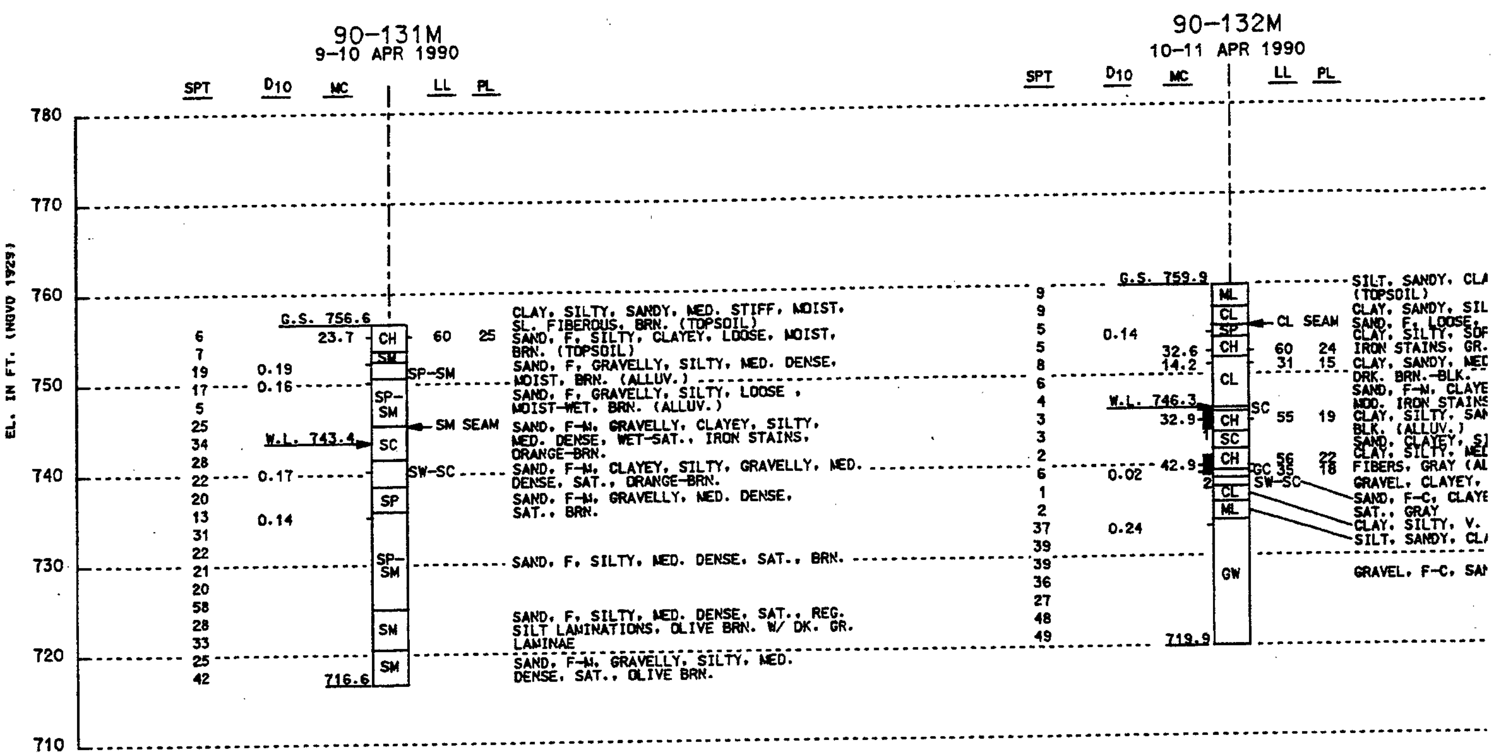
AE APPROVING OFFICIAL:

DESIGN MEMORANDUM
CHASKA - STAGE 3
FLOOD CONTROL - EAST CREEK
CHASKA PROJECT — CHASKA, MINNESOTA
GEOLOGICAL DATA
BORING LOGS
82-45M, 82-46M AND 88-98M

DESIGNED:
CHECKED:
DRAWN:
DESIGNED: LJL/PAW
CHECKED: CWB/JRC
DATE: OCTOBER 1993

CAD FILE NAME: CHS3SHO2.DGN
SPEC NO: DACW37-90-B-0000
DRAWING NUMBER: PLATE D-5
SHT 5 OF 16

2

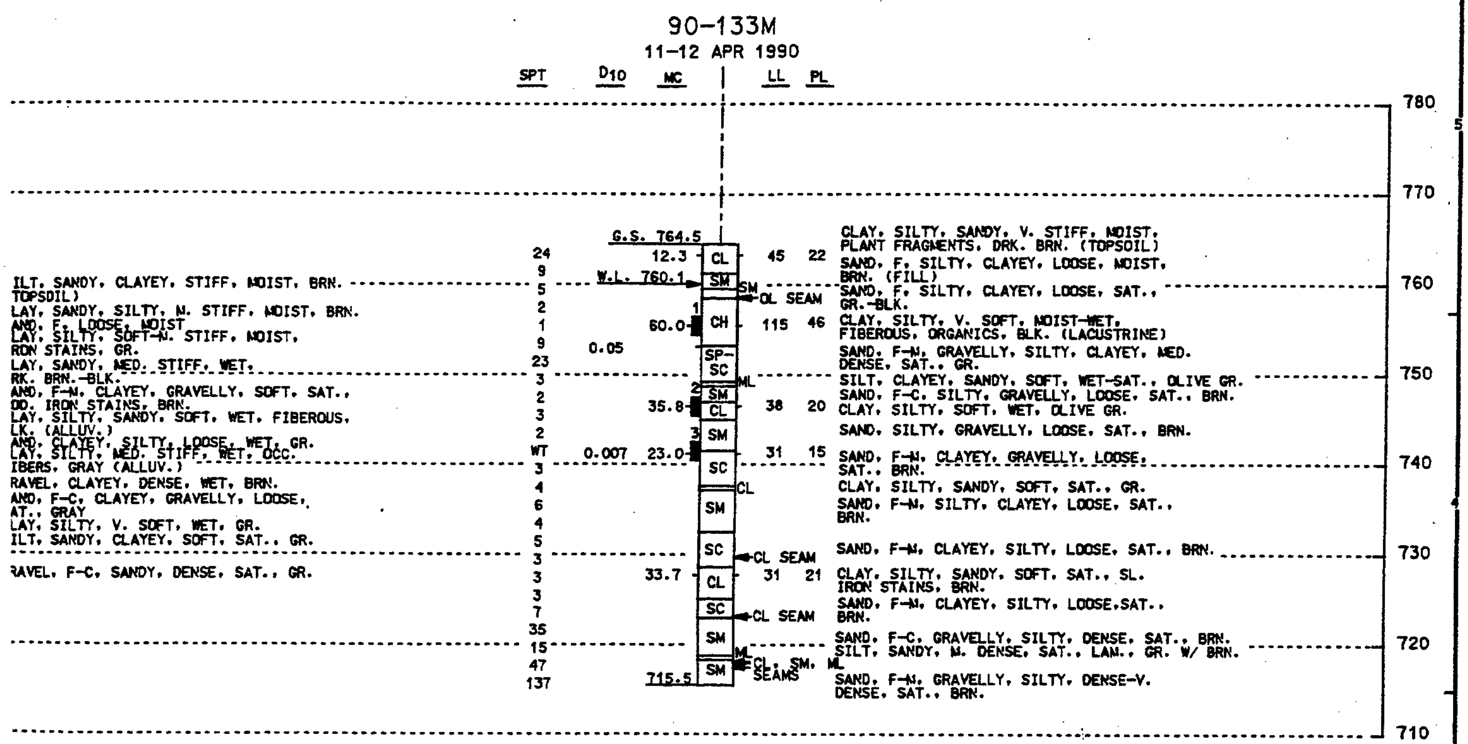


NOTES:

1. WATER LEVEL DETERMINED AFTER 40 MIN. WITH HOLLOW STEM AUGER SET AT EL. 742.6 AND HOLE OPEN TO EL. 742.1. HOLE SAMPLED TO EL. 740.6.
2. HOLLOW STEM AUGER WAS SET FROM EL. 756.6 TO 736.3. DRILLED WITH MUD FROM EL. 736.3 TO EL. 718.6. SAMPLER DRIVEN TO EL. 716.6.
3. HOLE BACKFILLED WITH TRMIED CEMENT-BENTONITE GROUT.

NOTES:

1. WATER LEVEL WAS DETERMINED AFTER 15 MIN. WIT HOLLOW STEM AUGER SET TO EL. 739.9. HOLE OPE EL. 740.1. AND SAMPLER DRIVEN TO EL. 737.9.
2. HOLLOW STEM AUGER WAS SET FROM EL. 759.9 TO 739.9. DRILLED WITH MUD TO EL. 721.9. SAMPLE DRIVEN TO EL. 719.9.
3. UNDISTURBED SAMPLES WERE TAKEN IN AN ADJACEN HOLE WITH 3" X 30" SHELBY TUBES.
4. HOLES BACKFILLED WITH TREMIED CEMENT-BENTONI GROUT.



NOTES:

1. WATER LEVEL WAS DETERMINED AFTER 30 MIN. WITH HOLLOW STEM AUGER SET TO EL. 755.5. HOLE OPEN TO EL. 753.6 AND SAMPLER DRIVEN TO EL. 750.5.
2. HOLLOW STEM AUGER WAS SET FROM EL. 764.5 TO EL. 740.5. DRILLED WITH MUD TO EL. 716.5. SAMPLER DRIVEN TO EL. 715.5.
3. UNDISTURBED SAMPLES WERE TAKEN IN AN ADJACENT HOLE WITH 3" X 30" SHELBY TUBES.
4. HOLES BACKFILLED WITH TREMIED CEMENT-BENTONITE GROUT.

ER 15 MIN. WITH
39.9, HOLE OPEN TO
TO EL. 737.9.
EL. 759.9 TO EL.
721.9. SAMPLER
IN AN ADJACENT
S.
CEMENT-BENTONITE

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

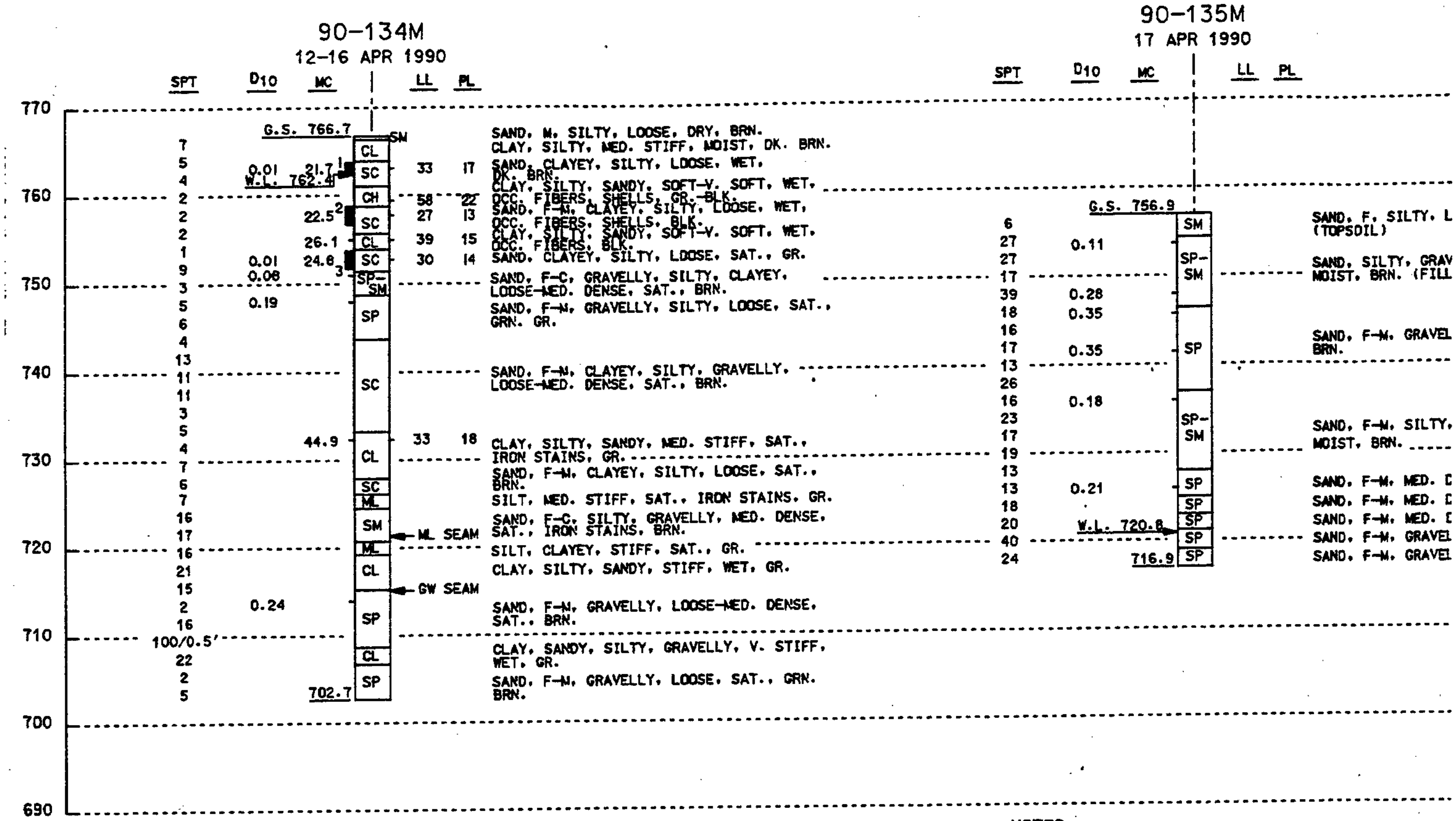
DESIGN MEMORANDUM
CHASKA - STAGE 3
FLOOD CONTROL - EAST CREEK
CHASKA PROJECT — CHASKA, MINNESOTA

GEOLOGICAL DATA
BORING LOGS
90-131M THRU 90-133M

DESIGNED:
CHECKED:
DRAWN:
DESIGNED: LJL/PAW
CHECKED: CWB/JRC
DATE: OCTOBER 1993

CAD FILE NAME: CHS3SH03.DGN
SPEC NO: DACW37-90-B-0000
DRAWING NUMBER: PLATE D-6
SHT 6 OF 16

2

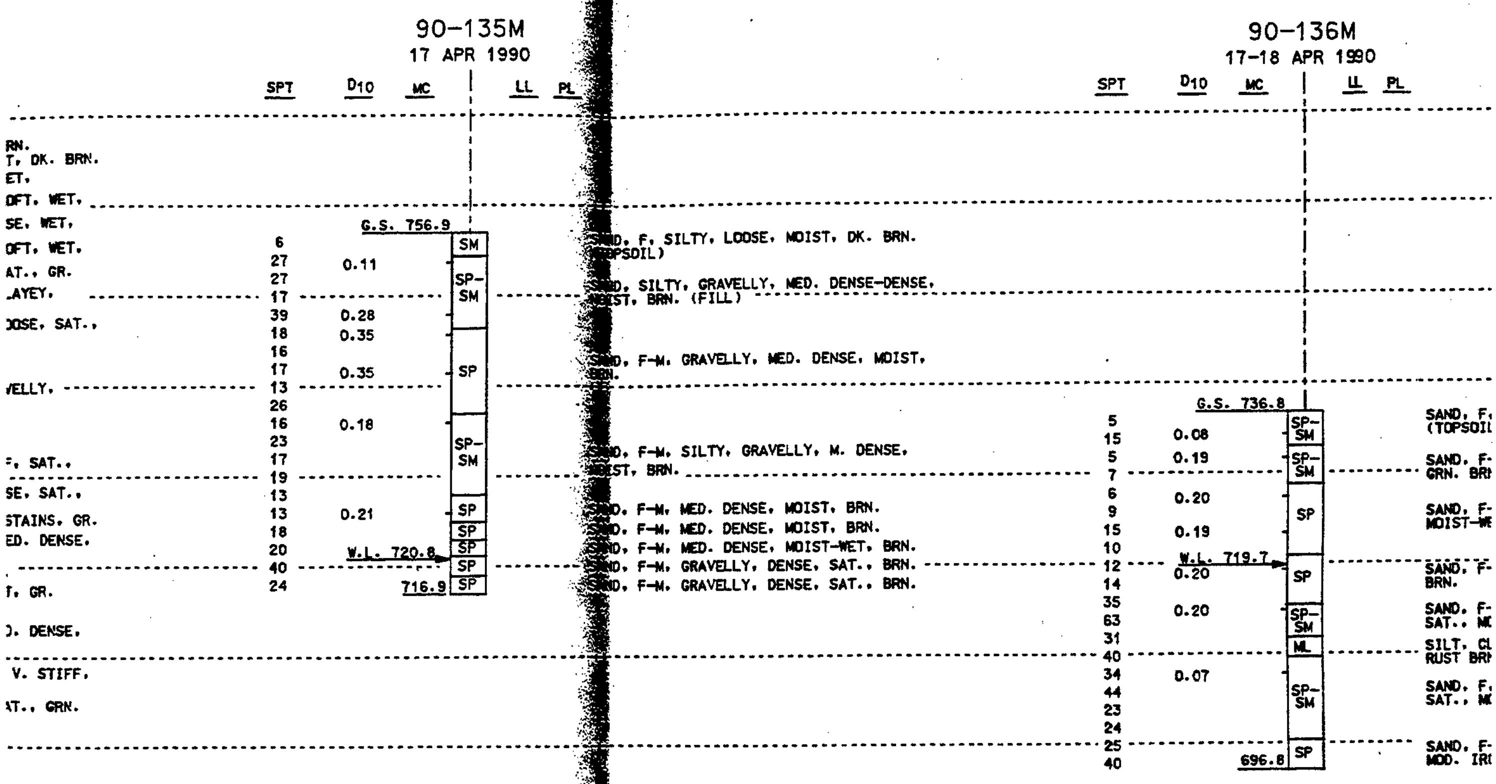


NOTES:

1. WATER LEVEL DETERMINED AFTER APPROX. 17 HRS. WITH:
   BOTTOM OF AUGER AT EL.751.7
   BOTTOM OF HOLE AT EL.754.0
   AFTER SAMPLING TO EL.750.7.
2. HOLLOW STEM AUGER WAS SET FROM EL. 766.7 TO EL. 751.7. DRILLED WITH MUD TO EL. 700.7. SAMPLER WAS DRIVEN TO EL. 702.7.
3. ENCOUNTERED ARTESIAN CONDITION WITH SAMPLER DRIVEN TO EL. 702.7. DISCHARGE WAS 25 GAL/MIN AFTER 10 MIN.
4. UNDISTURBED SAMPLES WERE TAKEN FROM AN ADJACENT HOLE WITH 3" X 30" SHELBY TUBES.
5. HOLE WAS BACKFILLED WITH TREMIED CEMENT GROUT AND SEALED WITH BENTONITE. TOP 10 FT BACKFILLED WITH SAND AND CLAY CUTTINGS.

NOTES:

1. WATER LEVEL WAS DETERMINED AFTER 1 HR WITH HOLLOW STEM AUGER SET TO EL. 718.9, HOLE OP EL. 719.4 AND SAMPLER DRIVEN TO EL. 716.9.
2. HOLE BACKFILLED WITH TREMIED CEMENT-BENTONITE GROUT.



NOTES:

1. WATER LEVEL WAS DETERMINED AFTER 1 HR WITH HOLLOW STEM AUGER SET TO EL. 718.9. HOLE OPEN TO EL. 719.4 AND SAMPLER DRIVEN TO EL. 716.9.
2. HOLE BACKFILLED WITH TREMIED CEMENT-BENTONITE GROUT.

NOTES:

1. WATER LEVEL WAS DETERMINED AFTER 16 HOLLOW STEM AUGER SET TO EL. 716.8, EL. 718.3, AND SAMPLER DRIVEN TO EL.
2. HOLLOW STEM AUGER WAS SET FROM EL. 7 716.8. DRILLING MUD WAS USED TO EL.6 DRIVEN TO EL. 696.8.
3. HOLE BACKFILLED WITH TREMIED CEMENT-BENTONITE GROUT.

SYMBOL	
AE APPROVING O	
DESIGNED:	
CHECKED:	
DRAWN:	
DESIGNED: L.	
CHECKED: C	
DATE: OCTOBER	

E F G

90-136M

17-18 APR 1990

SPT	D_{10}	MC		LL	PL	ELEV.	DESCRIPTION
						G.S. 736.8	
5			SP-SM				SAND, F, SILTY, LOOSE, MOIST, DK. BRN. (TOPSOIL)
15	0.08						
5	0.19		SP-SM				SAND, F-M, SILTY, LOOSE, WET, LAM., GRN. BRN. W/ DK. BRN. (ALLUV.)
7							
6	0.20		SP				SAND, F-M, LOOSE-MED. DENSE, MOIST-WET, BRN.
9							
15	0.19						
10						W.L. 719.7	
12	0.20		SP				SAND, F-M, MED. DENSE, WET-SAT., GRN BRN.
14							
35	0.20		SP-SM				SAND, F-M, SILTY, GRAVELLY, DENSE, SAT., MOD. IRON STAINS, RUST BRN.
63							
31			ML				SILT, CLAYEY, V. STIFF, WET, LAM., GR. W/ RUST BRN.
40							
34	0.07		SP-SM				SAND, F, SILTY, MED. DENSE-DENSE, SAT., MOD. IRON STAINS, BRN.
44							
23							
24							
25			SP				SAND, F-M, MED. DENSE-DENSE, SAT., MOD. IRON STAINS, BRN.
40						696.8	

Elevation scale: 770, 760, 750, 740, 730, 720, 710, 700, 690

F, SILTY, LOOSE, MOIST, DK. BRN.
IL)

SILTY, GRAVELLY, MED. DENSE-DENSE,
BRN. (FILL)

F-M, GRAVELLY, MED. DENSE, MOIST.

F-M, SILTY, GRAVELLY, M. DENSE,
BRN.

F-M, MED. DENSE, MOIST, BRN.
F-M, MED. DENSE, MOIST, BRN.
F-M, MED. DENSE, MOIST-WET, BRN.
F-M, GRAVELLY, DENSE, SAT., BRN.
F-M, GRAVELLY, DENSE, SAT., BRN.

1 HR WITH
9, HOLE OPEN TO
L. 716.9.
NT-

NOTES:

1. WATER LEVEL WAS DETERMINED AFTER 16 HRS WITH HOLLOW STEM AUGER SET TO EL. 716.8, HOLE OPEN TO EL. 718.3, AND SAMPLER DRIVEN TO EL. 714.8.
2. HOLLOW STEM AUGER WAS SET FROM EL. 736.8 TO EL. 716.8. DRILLING MUD WAS USED TO EL.698.8. SAMPLER DRIVEN TO EL. 696.8.
3. HOLE BACKFILLED WITH TREMIED CEMENT-BENTONITE GROUT.

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

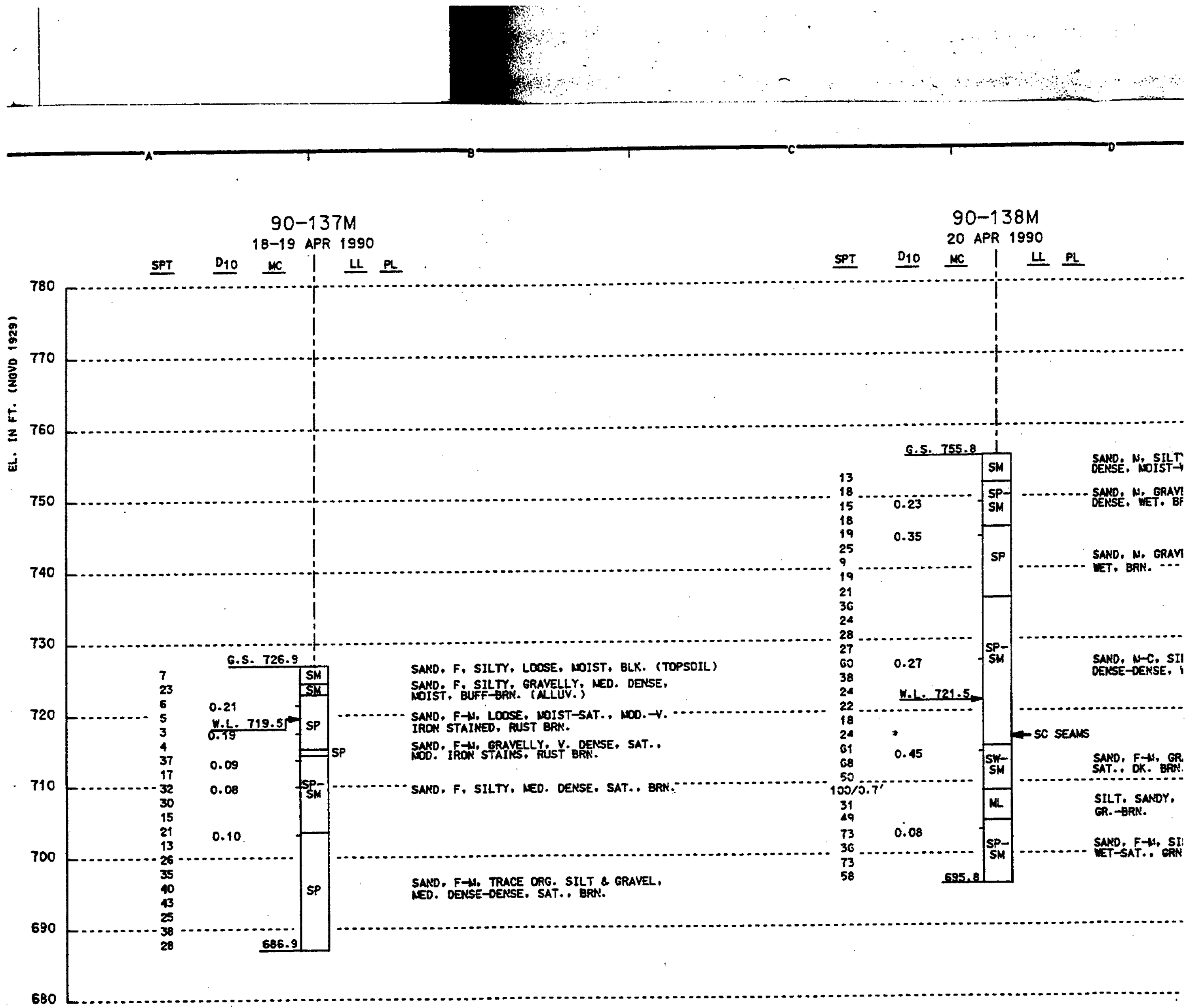
DESIGN MEMORANDUM
CHASKA - STAGE 3
FLOOD CONTROL - EAST CREEK
CHASKA PROJECT CHASKA, MINNESOTA

GEOLOGICAL DATA
BORING LOGS
90-134M THRU 90-136M

DESIGNED:
CHECKED:
DRAWN:
DESIGNED: LJL/PAW
CHECKED: CWB/JRC
DATE: OCTOBER 1993

CAD FILE NAME: CHS3SH04.DGN
SPEC NO: DACW37-90-B-0000
DRAWING NUMBER: PLATE D-7
SHT 7 OF 16

E

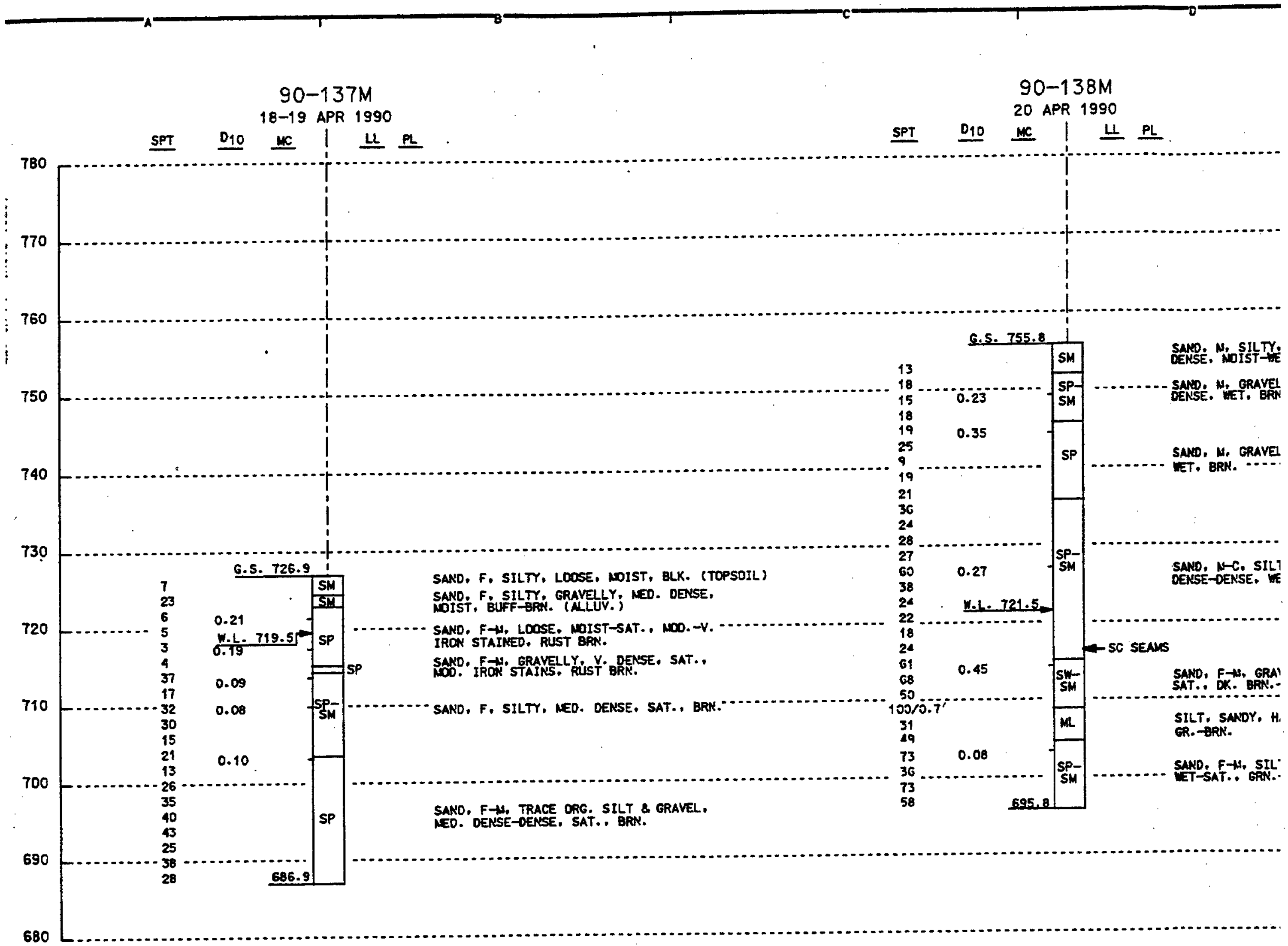


NOTES:

1. WATER LEVEL DETERMINED AFTER 1 HR WITH HOLLOW STEM AUGER SET TO EL. 716.9. HOLE OPEN TO EL. 718.2. AND SAMPLER DRIVEN TO EL. 714.9.
2. HOLLOW STEM AUGER WAS SET FROM EL. 726.9 TO EL. 716.9. DRILLING MUD WAS USED TO STABILIZE HOLE TO EL. 688.9. SAMPLER WAS DRIVEN TO EL. 686.9.
3. HOLE BACKFILLED WITH TREMIED CEMENT-BENTONITE GROUT.

NOTES:

1. WATER LEVEL DETERMINED AFTER 15 MINUTES STEM AUGER SET TO EL. 719.8. HOLE OPEN T EL. 720.5 AND SAMPLER DRIVEN TO EL. 717.
2. HOLLOW STEM AUGER WAS SET FROM EL. 755.8 719.8. DRILLING MUD WAS USED TO STABILIZ EL. 697.8. SAMPLER WAS DRIVEN TO EL. 695
3. HOLE BACKFILLED WITH TREMIED CEMENT-BENTONITE GROUT.

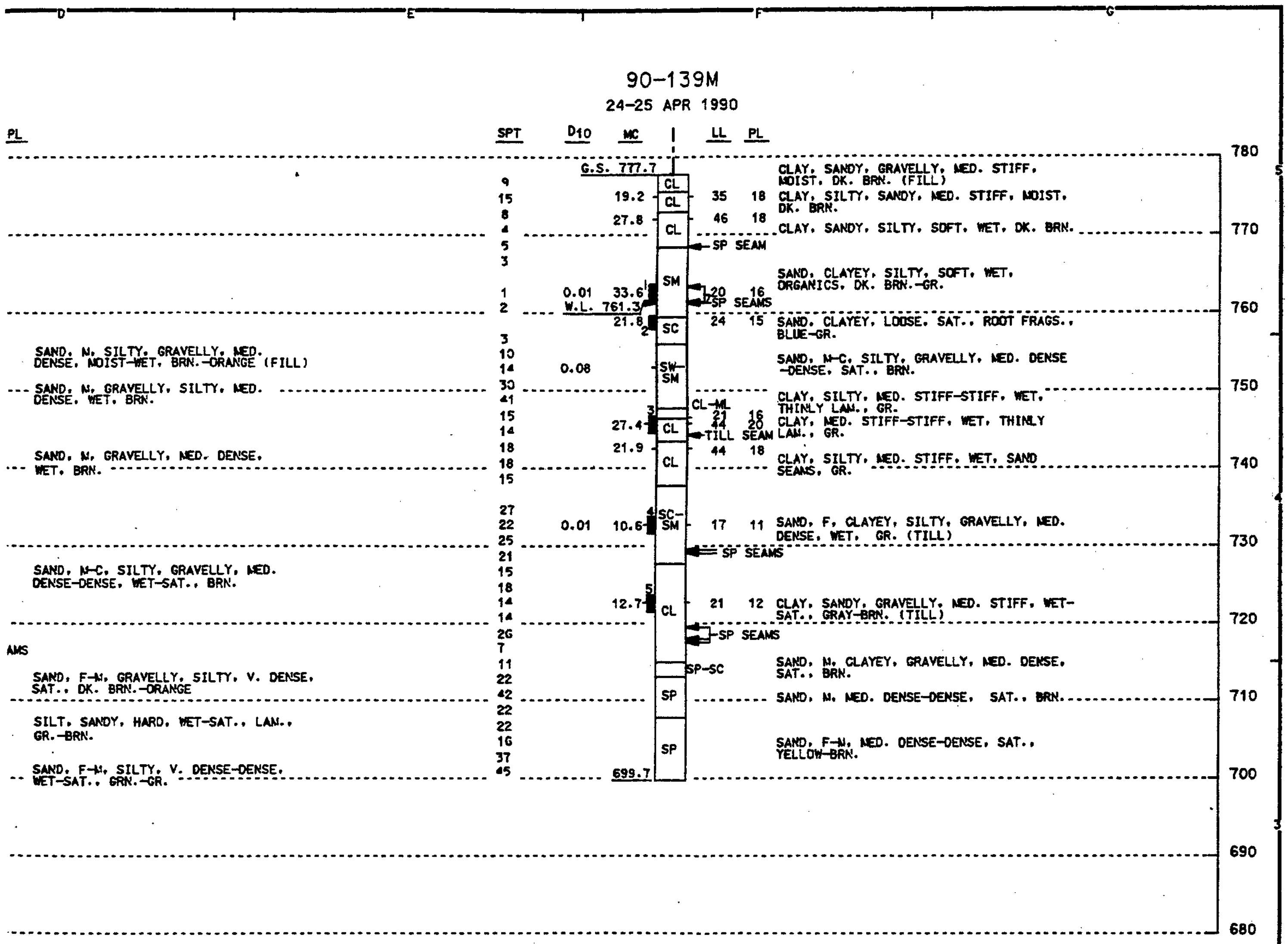


NOTES:

1. WATER LEVEL DETERMINED AFTER 1 HR WITH HOLLOW STEM AUGER SET TO EL. 716.9. HOLE OPEN TO EL. 718.2. AND SAMPLER DRIVEN TO EL. 714.9.
2. HOLLOW STEM AUGER WAS SET FROM EL. 726.9 TO EL. 716.9. DRILLING MUD WAS USED TO STABILIZE HOLE TO EL. 688.9. SAMPLER WAS DRIVEN TO EL. 686.9.
3. HOLE BACKFILLED WITH TREMIED CEMENT-BENTONITE GROUT.

NOTES:

1. WATER LEVEL DETERMINED AFTER 15 MINUTES W STEM AUGER SET TO EL. 719.8. HOLE OPEN TO EL. 720.5 AND SAMPLER DRIVEN TO EL. 717.8
2. HOLLOW STEM AUGER WAS SET FROM EL. 755.8 719.8. DRILLING MUD WAS USED TO STABILIZE EL. 697.8. SAMPLER WAS DRIVEN TO EL. 695.
3. HOLE BACKFILLED WITH TREMIED CEMENT-BENTONITE GROUT.



FTER 15 MINUTES WITH HOLLOW
9.8. HOLE OPEN TO
IVEN TO EL. 717.8.
T FROM EL. 755.8 TO EL.
USED TO STABILIZE HOLE TO
RIVEN TO EL. 695.8.
MIED CEMENT-

NOTES:

1. WATER LEVEL DETERMINED AFTER 1 HR WITH HOLLOW STEM AUGER SET TO EL. 759.7. HOLE OPEN TO EL. 759.7. AND SAMPLER DRIVEN TO EL. 759.7.
2. HOLLOW STEM AUGER WAS SET FROM EL. 777.7 TO EL. 759.7. DRILLING MUD WAS USED TO STABILIZE HOLE TO EL. 701.7. SAMPLER WAS DRIVEN TO EL. 699.7.
3. UNDISTURBED SAMPLES WERE TAKEN FROM AN ADJACENT HOLE WITH 3" X 30" SHELBY TUBES. UNDISTURBED SAMPLE #1 SHOWED SP IN THE TOP 17".
4. HOLES BACKFILLED WITH TREMIED CEMENT-BENTONITE GROUT.

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

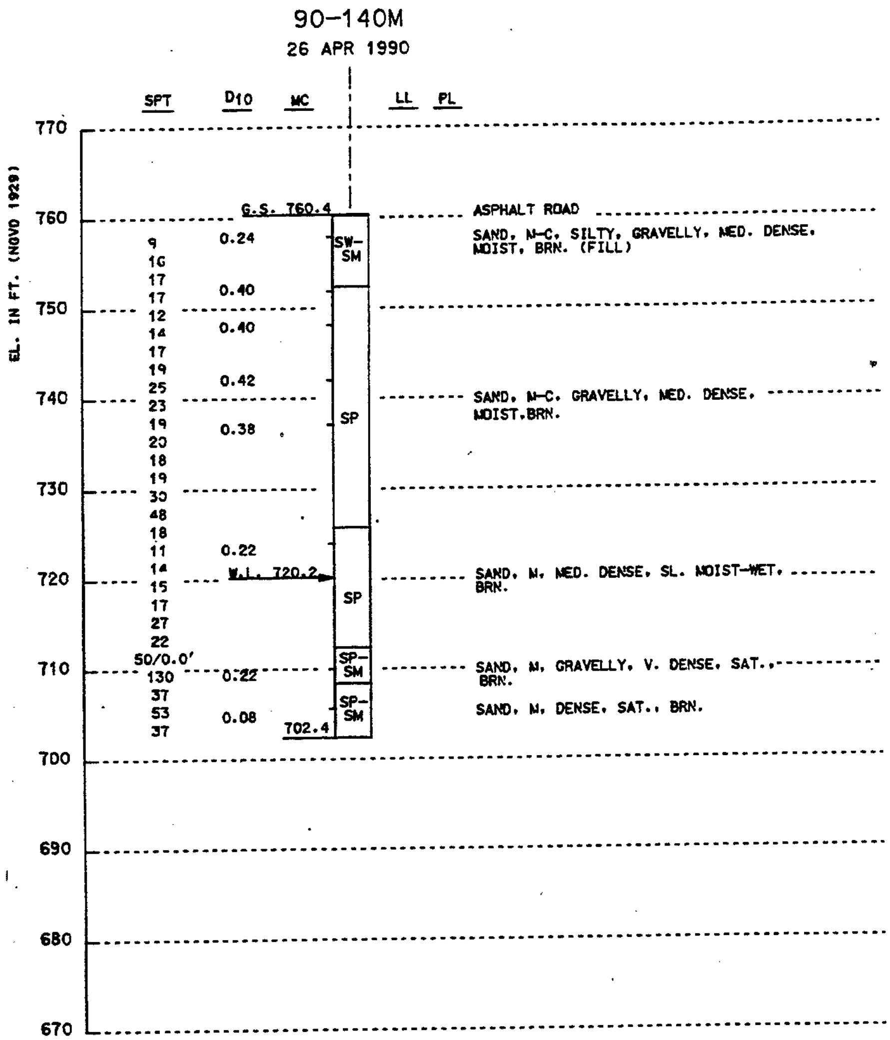
AE APPROVING OFFICIAL:

DESIGNED:
CHECKED:
DRAWN:
DESIGNED: LJL/PAW
CHECKED: CWB/JRC
DATE: OCTOBER 1993

DESIGN MEMORANDUM
CHASKA - STAGE 3
FLOOD CONTROL - EAST CREEK
CHASKA PROJECT CHASKA, MINNESOTA
GEOLOGICAL DATA
BORING LOGS
90-137M THRU 90-139M

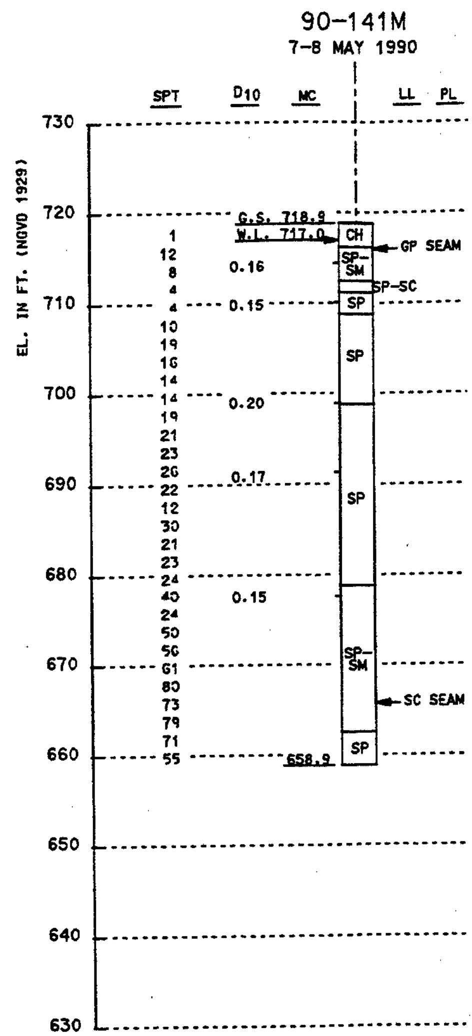
CAD FILE NAME: CHS3SH05.DGN
SPEC NO: DACW37-90-B-0000
DRAWING NUMBER: PLATE D-8
SHT 8 OF 16

3



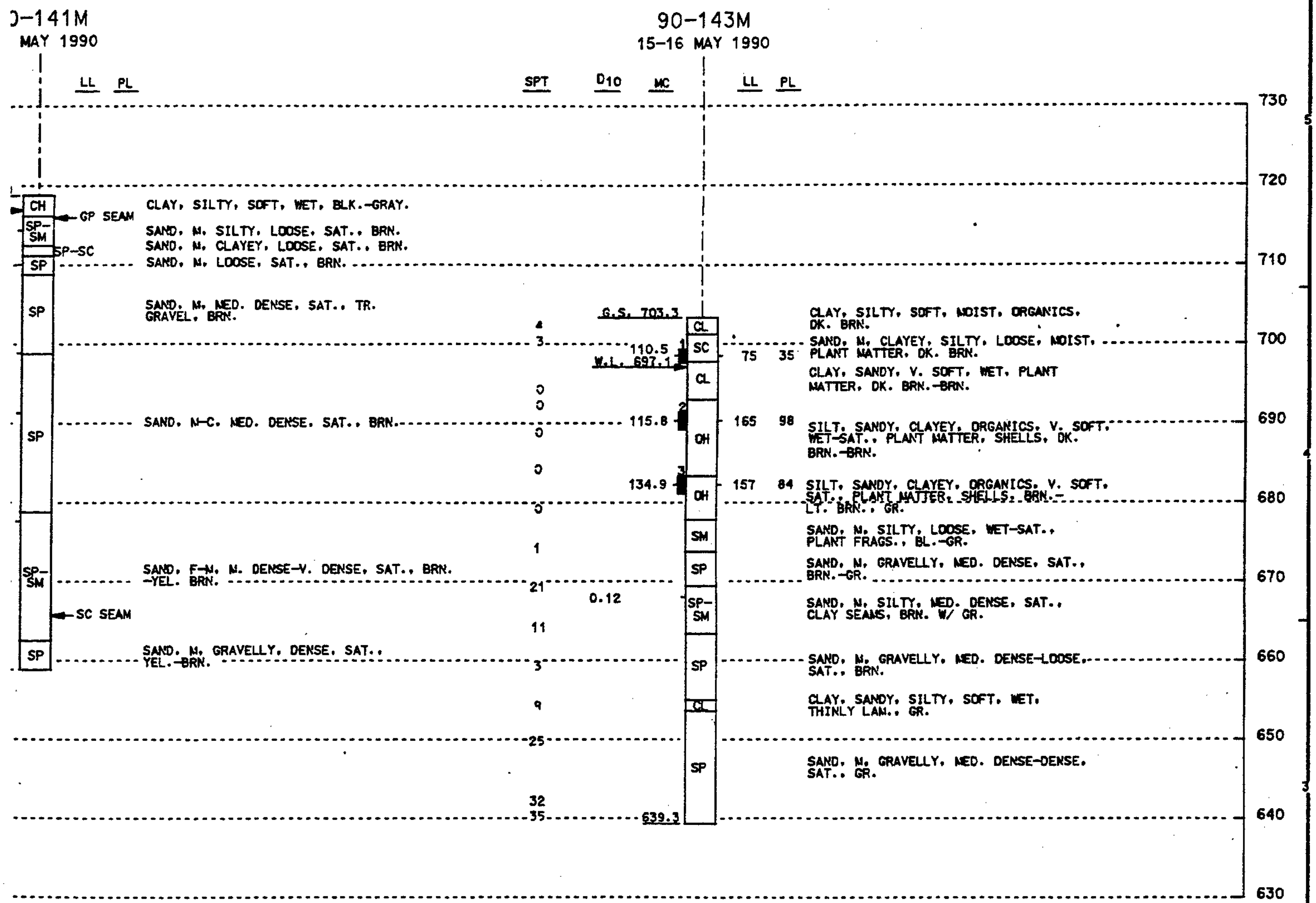
NOTES:

1. WATER LEVEL DETERMINED AFTER 30 MIN. WITH HOLLOW STEM AUGER SET TO EL. 718.4, HOLE OPEN TO EL. 719.3, AND SAMPLER DRIVEN TO EL. 716.4.
2. HOLLOW STEM AUGER WAS SET FROM EL. 760.4 TO EL. 718.4. DRILLING MUD WAS USED TO STABILIZE HOLE TO EL. 704.4. SAMPLER WAS DRIVEN TO EL. 702.4.
3. HOLE BACKFILLED WITH TREMIED CEMENT-BENTONITE GROUT.



NOTES:

1. WATER LEVEL DETERMINED AFT STEM AUGER SET TO EL. 712. 713.7, AND SAMPLER DRIVEN
2. HOLLOW STEM AUGER WAS SET 712.9. DRILLING MUD WAS US EL. 660.9. SAMPLER WAS DRI
3. HOLE BACKFILLED WITH TREMI BENTONITE GROUT.



DETERMINED AFTER 25 MIN. WITH HOLLOW
SET TO EL. 712.9. HOLE OPEN TO EL.
SAMPLER DRIVEN TO EL. 710.9.
AUGER WAS SET FROM EL. 718.9 TO EL.
LING MUD WAS USED TO STABILIZE HOLE TO
SAMPLER WAS DRIVEN TO EL. 658.9.
LLED WITH TREMIED CEMENT-
ROUT.

NOTES:

1. WATER LEVEL DETERMINED AFTER 20 MIN. WITH HOLLOW STEM AUGER SET TO EL. 697.3. HOLE OPEN TO EL. 695.0, AND SAMPLER DRIVEN TO EL. 693.3.
2. HOLLOW STEM AUGER WAS SET FROM EL. 703.3 TO EL. 683.3. DRILLING MUD WAS USED TO STABILIZE HOLE TO EL. 641.3. SAMPLER WAS DRIVEN TO EL. 639.3.
3. 1 GAL./MIN. ARTESIAN FLOW ENCOUNTERED AT EL. 673.3.
4. UNDISTURBED SAMPLES WERE TAKEN FROM SAME HOLE WITH 3" X 30" SHELBY TUBES.
5. HOLE BACKFILLED WITH TREMIED CEMENT-BENTONITE GROUT.

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

DESIGN MEMORANDUM
CHASKA - STAGE 3
FLOOD CONTROL - EAST CREEK
CHASKA PROJECT CHASKA, MINNESOTA

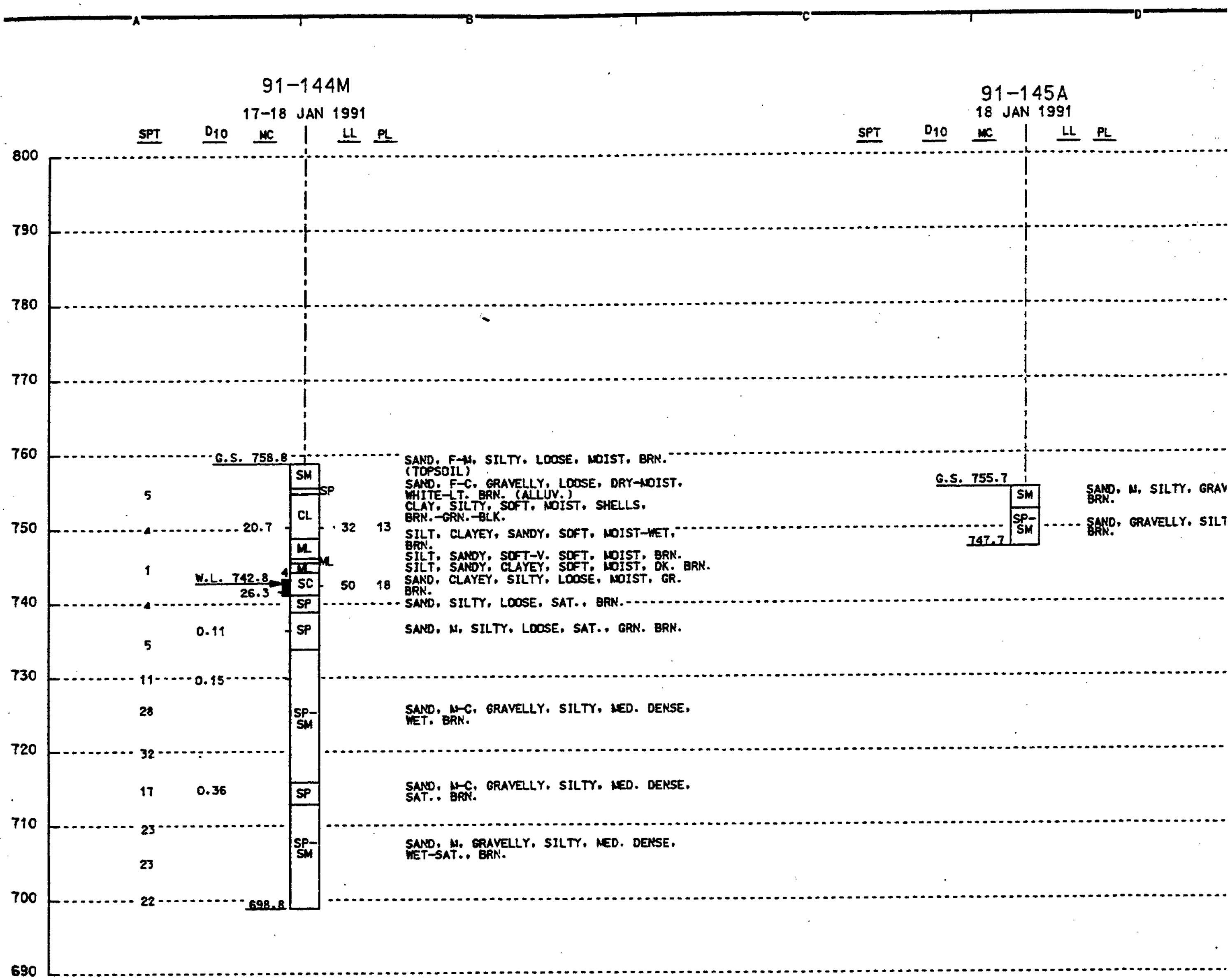
GEOLOGICAL DATA
BORING LOGS
90-140M, 90-141M AND 90-143M

DESIGNED:	
CHECKED:	
DRAWN:	
DESIGNED: LJL/PAW	
CHECKED: CWB/JRC	CAD FILE NAME: CHS3SH06.DGN
DATE: OCTOBER 1993	SPEC NO: DACW37-90-B-0000

DRAWING NUMBER: PLATE D-9

SHT 9 OF 16

2



NOTES:

1. WATER LEVEL DETERMINED AFTER 1 HR. 10 MIN. WITH HOLLOW STEM AUGER SET TO EL. 738.8. SAMPLER DRIVEN TO EL. 733.8, AND HOLE OPEN TO EL. 741.4.
2. HOLLOW STEM AUGER WAS SET FROM EL. 758.8 TO EL. 738.8. DRILLING MUD WAS USED TO STABILIZE HOLE TO EL. 703.8. SAMPLER WAS DRIVEN TO EL. 698.8.
3. UNDISTURBED SAMPLES WERE TAKEN FROM AN ADJACENT HOLE WITH A 5" DIAMETER PISTON SAMPLER.
4. HOLES BACKFILLED WITH CEMENT-BENTONITE GROUT.

NOTES:

1. WATER LEVEL WAS NOT ENCOUNTERED.
2. HOLLOW STEM AUGER ADVANCED TO EL. 747.7'.

D E F G

91-146M

22-23 JAN 1991

SPT	D10	MC	Elev. / Symbol	LL	PL	Description
			G.S. 795.9 ML			SILT, GRAVELLY, DRY-MOIST, LT. BRN. (FILL)
			ML			SILT, GRAVELLY, DRY-MOIST, LT. BRN.
			CL			CLAY, SILTY, GRAVELLY, V. STIFF, DRY-MOIST, LAM., LT. BRN.
23		10.2	CL	23	12	CLAY, SILTY, V.STIFF, MOIST, LT. BRN. (TILL)
		28.5		47	18	
101/.5'			ML —BOULDER			SILT, GRAVELLY, V. STIFF, MOIST, GR. (TILL)
17						
		15.5	CL	33	13	CLAY, SILTY, GRAVELLY, V. STIFF, MOIST, GR. (TILL)
27						
22			—SP SEAM			
32						
28						
27			CL			CLAY, SILTY, GRAVELLY, V. STIFF-HARD, MOIST, GR. (TILL)
34						
40						
27		735.9	CL			CLAY, SILTY, V. STIFF-HARD, MOIST, LAMINATED, GR. (TILL)

Elevation scale: 800, 790, 780, 770, 760, 750, 740, 730, 720, 710, 700, 690

D. M. SILTY, GRAVELLY, MOIST.

D. GRAVELLY, SILTY, MOIST.

NOTES:

1. WATER LEVEL NOT DETERMINED
2. HOLLOW STEM AUGER WAS SET FROM EL. 795.4 TO EL. 740.9. SAMPLER WAS DRIVEN TO EL. 735.9.
3. CASING WAS PULLED AND HOLE BACKFILLED WITH AUGER CUTTINGS TO EL. 790.4. CEMENT-CLAY GROUT USED TO BACKFILL TOP OF HOLE.

TERED.
TO EL. 747.7'.

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

DESIGN MEMORANDUM
CHASKA - STAGE 3
FLOOD CONTROL - EAST CREEK
CHASKA PROJECT CHASKA, MINNESOTA

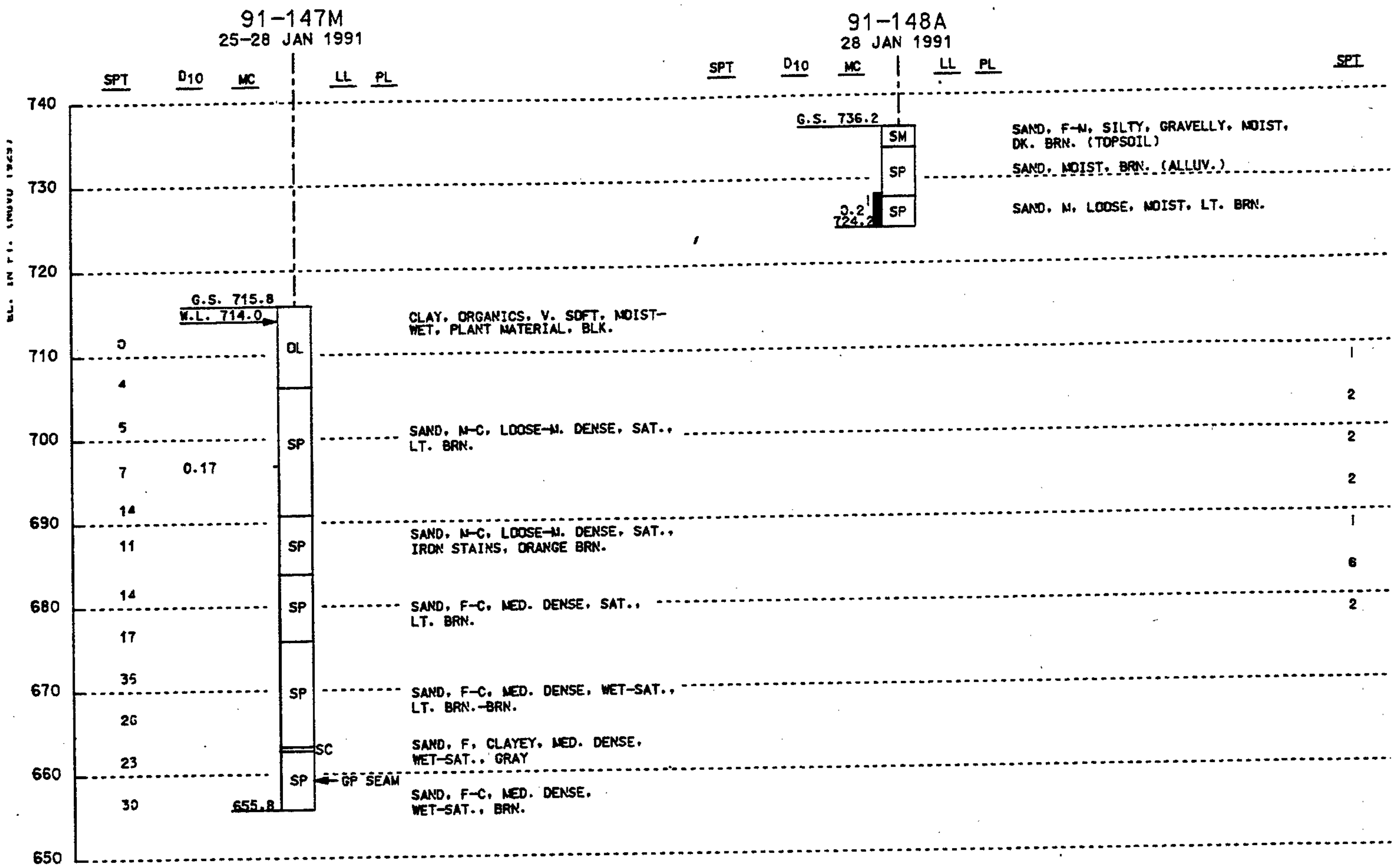
GEOLOGICAL DATA
BORING LOGS
91-144M, 91-145A AND 91-146M

DESIGNED:
CHECKED:
DRAWN:
DESIGNED: LJL/PAW
CHECKED: CWB/JRC
DATE: OCTOBER 1993

CAD FILE NAME: CHS3SH07.DGN
SPEC NO. DACW37-90-B-0000
DRAWING NUMBER: PLATE D-10
SHT 10 OF 16

D E

2



NOTES:

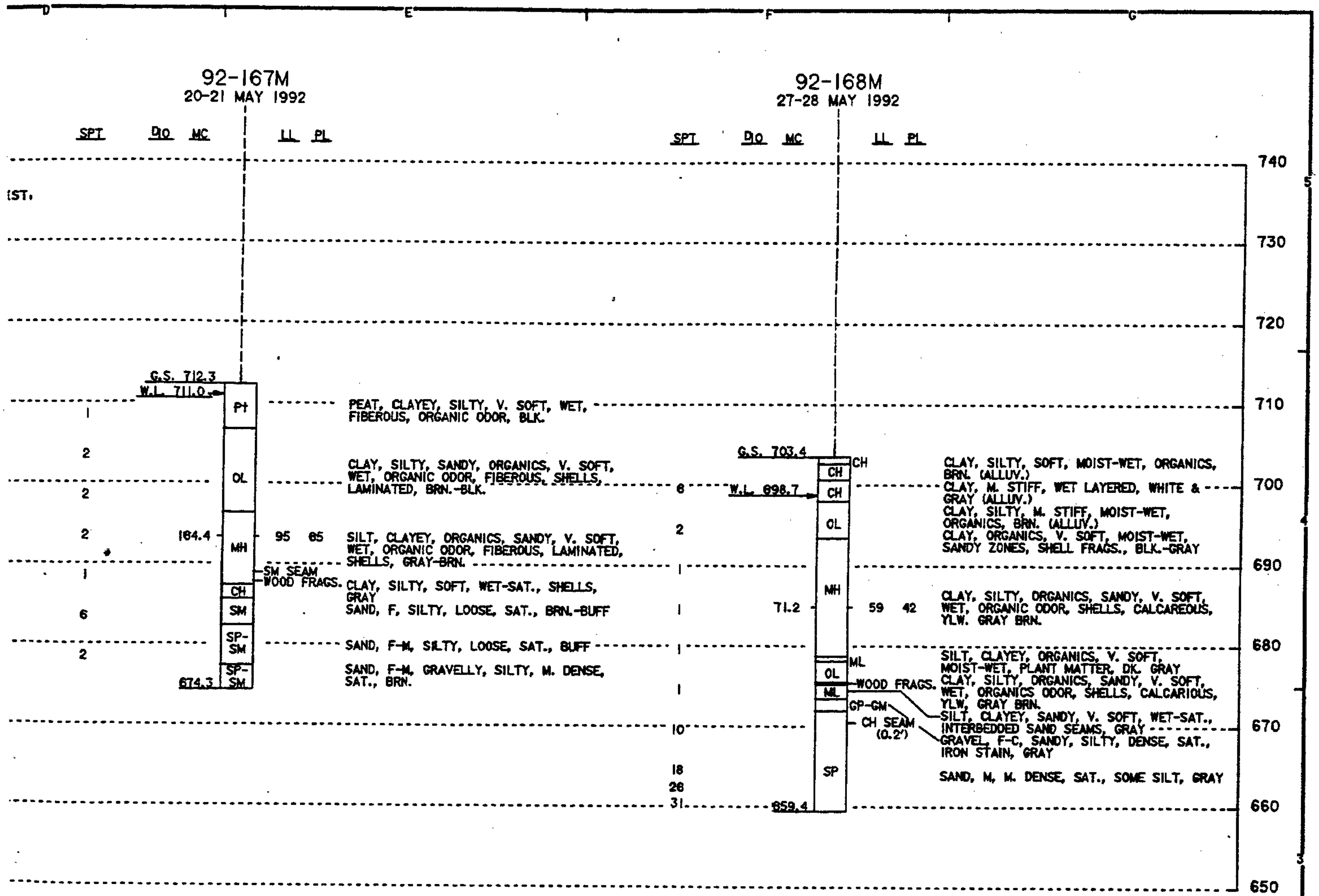
1. WATER LEVEL DETERMINED AFTER 25 MIN. WITH HOLLOW STEM AUGER SET TO EL. 710.8. SAMPLER DRIVEN TO EL. 705.8 AND HOLE OPEN TO EL. 710.1.
2. HOLLOW STEM AUGER WAS SET FROM EL. 715.8 TO EL. 706.8 DRILLING MUD WAS USED TO STABILIZE HOLE TO EL. 660.8. SAMPLER WAS DRIVEN TO EL. 655.8.
3. HEAVING SANDS ENCOUNTERED BETWEEN EL. 700.8' AND EL. 690.8' AND AGAIN AT EL. 670.8'.
4. OVERNIGHT CAVE-IN TO EL. 696.8' AFTER SAMPLING TO EL. 655.8' THE PREVIOUS DAY, WITH HSA SET TO EL. 706.8'.
5. HOLE ABANDONED AND BACKFILLED WITH TREMIED CEMENT-BENTONITE GROUT.

NOTES:

1. WATER LEVEL WAS NOT ENCOUNTERED.
2. HOLLOW STEM AUGER ADVANCED TO EL. 724.2'. TO OBTAIN BAG SAMPLE.
3. CASING WAS PULLED AND HOLE BACKFILLED WITH NATURAL MATERIAL.

NOTES

1. WA
2. 4" D
3. AF M D O
4. L(H E
5. HK H



NOTES

1. WATER LEVEL DETERMINED AFTER 40 MINUTES WITH:
   NO CASING IN HOLE. HOLE OPEN TO EL. 709.7
   AFTER SAMPLING TO EL. 707.3
2. 4" CASING INSTALLED TO EL. 708.3. HOLE STABILIZED WITH DRILLING MUD BELOW EL. 708.3.
3. ARTESIAN FLOW ENCOUNTERED AFTER SAMPLING TO EL. 682.3. DRILL MUD MEASURED ONE FOOT ABOVE GROUND SURFACE. WATER GAIN IN DRILL OUTS BELOW EL. 682.3. HOLE FLOWING APPROX. 2 GAL/MIN. OVER ONE FOOT CASING STICK-UP AFTER SAMPLING TO EL. 679.3.
4. LOST MUD CIRCULATION BETWEEN EL. 678.3 AND EL. 677.3. DRILL HOLE ABANDONED AFTER SAMPLING TO EL. 674.3 AND SAND HEAVED TO EL. 685.3.
5. HOLE BACKFILLED WITH BENTONITE CHIPS FROM EL. 685.3 TO TOP OF HOLE.

NOTES

1. WATER LEVEL DETERMINED AFTER 35 MINUTES WITH:
   BOTTOM OF HOLE AT EL. 697.7'
   AFTER SAMPLING TO EL. 693.4'.
2. SET 4" CASING TO EL. 699.4. HOLE STABILIZED WITH DRILLING MUD AND BARITE ADDITIVES BELOW EL. 699.4'.
3. ARTESIAN GROUNDWATER CONDITIONS DETERMINED BY DRIVING A 1¼" X 3'. * 10 SLOT WELL POINT INTO SAMPLE BORING TO EL. 658.4. TOTAL HEAD MEASURED AT EL. 706.6.
4. HOLE BACKFILLED WITH TREMIED CEMENT-BENTONITE GROUT.

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

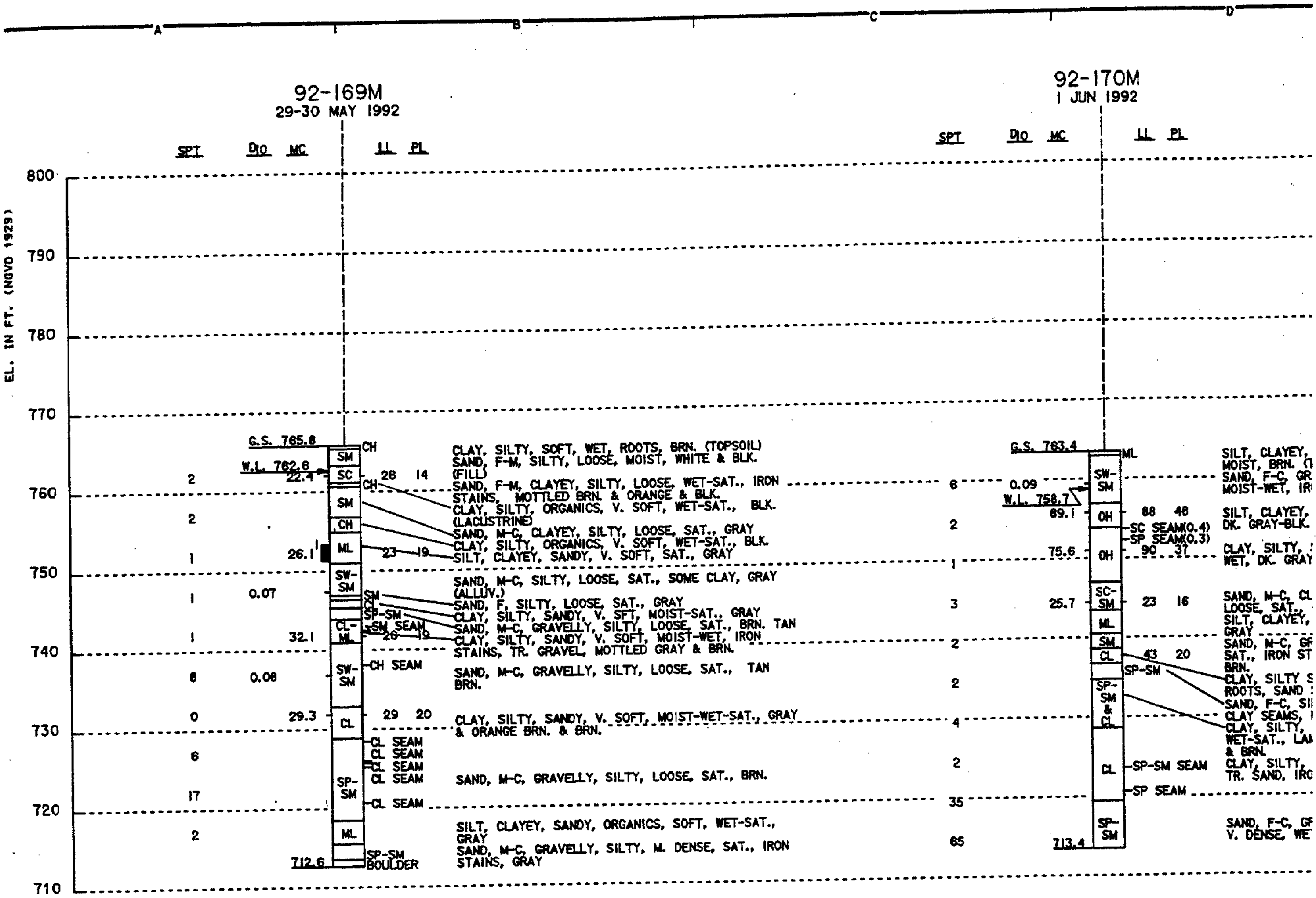
AE APPROVING OFFICIAL:

DESIGN MEMORANDUM
CHASKA - STAGE 3
FLOOD CONTROL - EAST CREEK
CHASKA PROJECT — CHASKA, MINNESOTA

GEOLOGICAL DATA
BORING LOGS
91-147M, 91-148A, 92-167M AND 92-168M

DESIGNED:	
CHECKED:	
DRAWN:	
DESIGNED: LJL/PAW	
CHECKED: CWB/JRC	
DATE: OCTOBER 1993	
CAD FILE NAME: CHS3SH08.DGN	SPEC NO: DACW37-90-B-0000
DRAWING NUMBER: PLATE D-11	SHT 8 OF 15

(2)

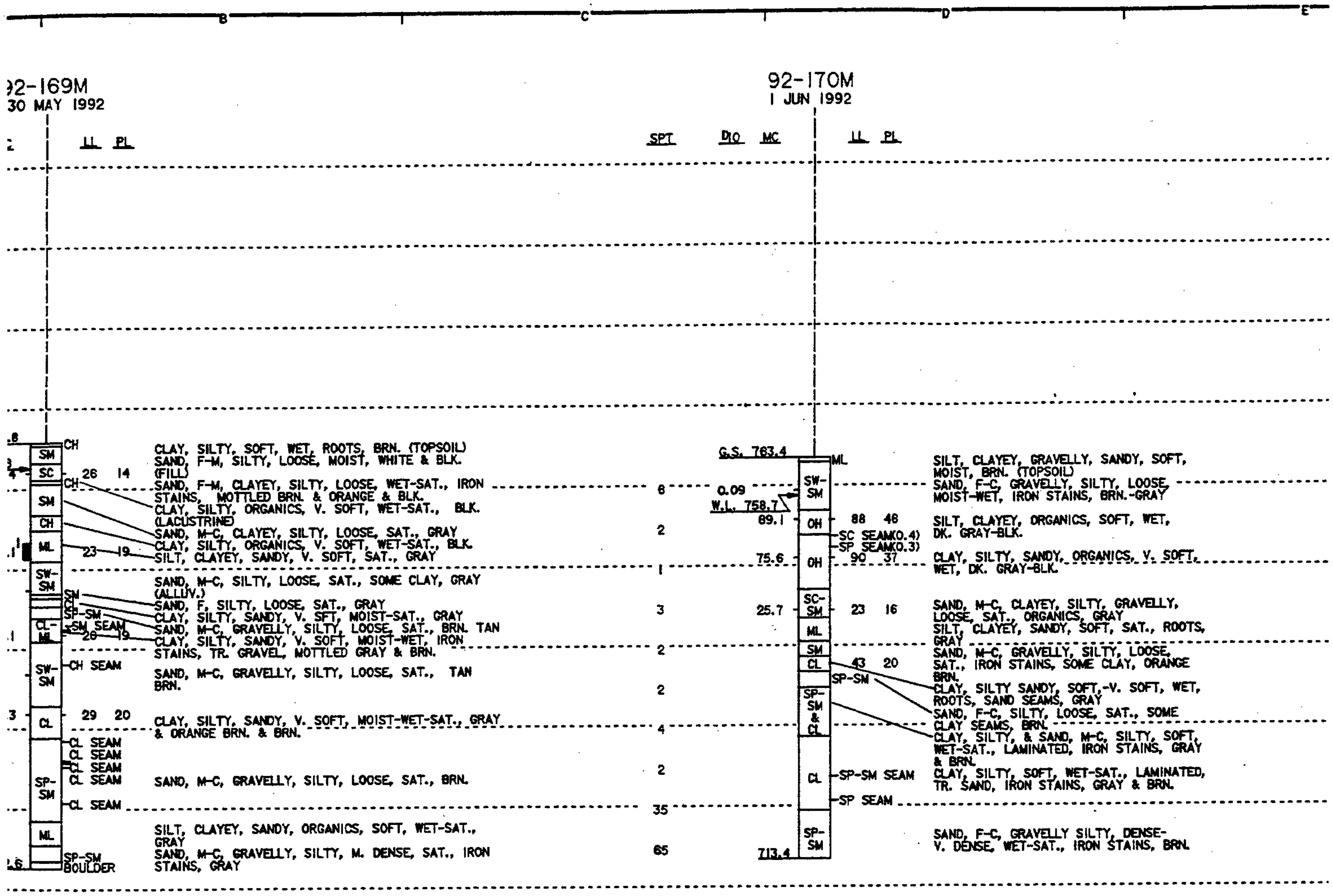


NOTES

1. WATER LEVEL DETERMINED AFTER 1 HR. WITH:
   BOTTOM OF AUGER AT EL. 760.8'
   BOTTOM OF HOLE AT EL. 759.8'
   AFTER SAMPLING TO EL. 755.8'.
2. HSA ADVANCED TO EL. 756.8'. HOLE STABILEZED WITH DRILLING MUD BELOW EL. 756.8'.
3. TWO 5" UNDISTURBED PISTON SAMPLES TAKEN FROM AN ADJACENT HOLE.
4. HOLES BACKFILLED WITH TREMIED CEMENT-BENTONITE GROUT.

NOTES

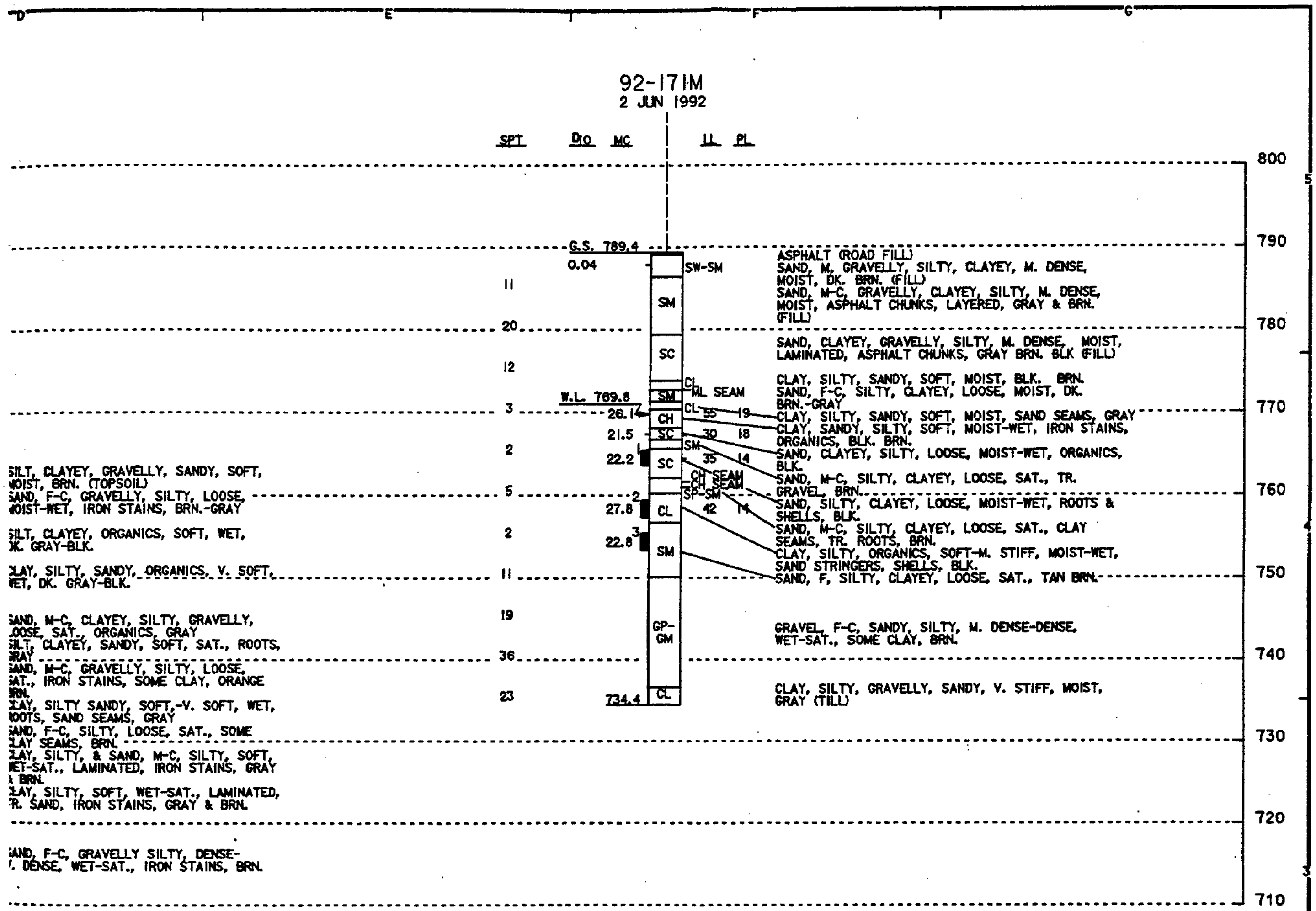
1. WATER LEVEL DETERMINED AFTER 1 HR. WITH:
   BOTTOM OF HSA AT EL. 758.4'
   BOTTOM OF HOLE AT EL. 758.2'
   AFTER SAMPLING TO EL. 753.4'.
2. HSA ADVANCED TO EL. 754.4'. HOLE STABILEZED WIT[H]
   BELOW EL. 754.4'.
3. HOLE BACKFILLED WITH TREMIED CEMENT-BENTONITE G[ROUT]
   CAPPED WITH NATURAL MATERIAL.



DETERMINED AFTER 1 HR. WITH:
AUGER AT EL. 760.8'
HOLE AT EL. 759.8'
LING TO EL. 755.8'.
TO EL. 756.8'. HOLE STABILEZED WITH DRILLING MUD
3.8'.
TURBED PISTON SAMPLES TAKEN FROM AN ADJACENT HOLE.
LED WITH TREMIED CEMENT-BENTONITE GROUT.

NOTES

1. WATER LEVEL DETERMINED AFTER 1 HR. WITH:
   BOTTOM OF HSA AT EL. 758.4'
   BOTTOM OF HOLE AT EL. 758.2'
   AFTER SAMPLING TO EL. 753.4'.
2. HSA ADVANCED TO EL. 754.4'. HOLE STABILEZED WITH DRILLING MUD BELOW EL. 754.4'.
3. HOLE BACKFILLED WITH TREMIED CEMENT-BENTONITE GROUT AND CAPPED WITH NATURAL MATERIAL.



WITH:

BILEZED WITH DRILLING MUD

BENTONITE GROUT AND

NOTES

1. WATER LEVEL DETERMINED AFTER 55 MINUTES WITH:
   BOTTOM OF HSA AT EL. 769.4'
   BOTTON OF HOLE AT EL. 766.8'
   AFTER SAMPLING TO EL. 764.4'.
2. HSA ADVANCED TO EL. 765.4'. HOLE SATABILIZED WITH DRILLING MUD BELOW EL. 765.4'.
3. THREE 5" UNDISTURBED PISTON SAMPLES TAKEN FROM AN OFFSET HOLE.
4. HOLES BACKFILLED WITH TREMIED CEMENT-BENTONITE GROUT.

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

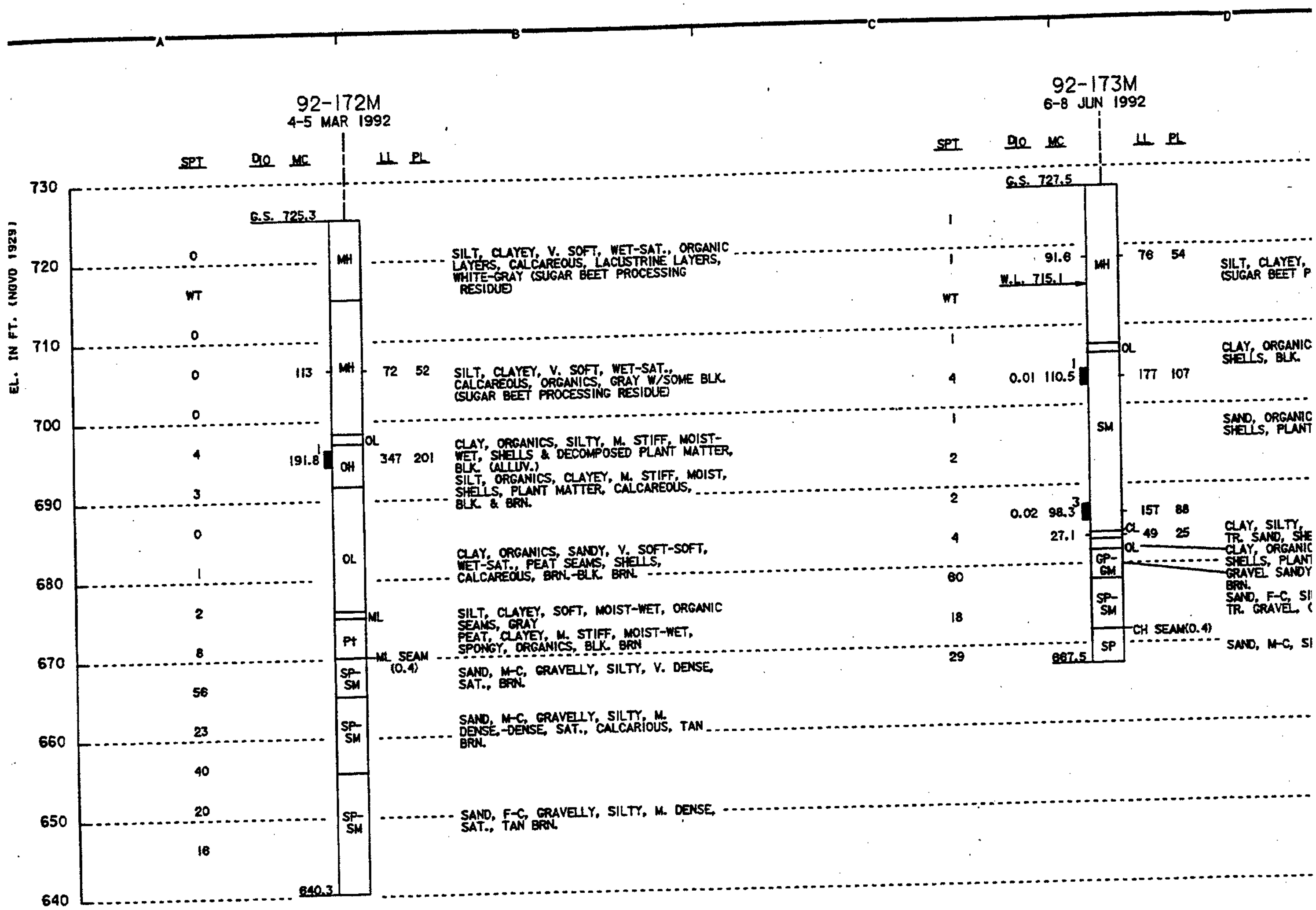
DESIGN MEMORANDUM
CHASKA - STAGE 3
FLOOD CONTROL - EAST CREEK
CHASKA PROJECT — CHASKA, MINNESOTA

GEOLOGICAL DATA
BORING LOGS
92-169M THRU 92-171M

DESIGNED:
CHECKED:
DRAWN:
DESIGNED: LJL/PAW
CHECKED: CWB/JRC
DATE: OCTOBER 1993

CAD FILE NAME: CHS3SH09.DGN
SPEC NO: DACW37-90-B-0000
DRAWING NUMBER: PLATE D-12
SHT 12 OF 16

3



NOTES

1. WATER WAS ENCOUNTERED AT EL. 703.1' AND ROSE TO EL. 712.1' WITHIN 125 MIN. FINAL STATIC WATER LEVEL WAS NOT DETERMINED.
2. HSA ADVANCED TO EL. 701.3'. HOLE STABILIZED WITH DRILLING MUD BELOW EL. 701.3'.
3. HOLE BACKFILLED WITH TREMIED CEMENT-BENTONITE GROUT.

NOTES

1. WATER LEVEL DETERMINED AFTER 1 HR. WITH:
   BOTTOM OF AUGER AT EL. 702.5'
   BOTTOM OF HOLE AT EL. 701.3'
   AFTER SAMPLING TO EL. 697.5'
2. INSPECTOR NOTED VIGOROUS BUBBLING DOWNHOLE WHI WATER LEVEL. A (HEADSPACE) SAMPLE WAS CONTAINE WAS FOUND TO BE FLAMMABLE, POSSIBLY METHANE.
3. HSA ADVANCED TO EL. 698.5' HOLE STABILIZED WITH BELOW EL. 698.5'.
4. THREE 5" UNDISTURBED PISTON SAMPLES TAKEN FRO
5. HOLE BACKFILLED WITH TREMIED CEMENT-BENTONITE

92-174M
8 JUN 1992

SPT | D10 | MC | LL | PL

730

720 — G.S. 719.2

SILT, CLAYEY, ORGANICS, V. SOFT, SAT., GRAY (SUGAR BEET PROCESSING RESIDUE)

38 — SM — SAND, M-C, RUBBLY, SILTY, CLAYEY, ORGANICS, LOOSE-M. DENSE, MOIST, METAL, CONCRETE, WOOD, PLANT MATER. (FILL)

W.L. 713.1 — SM — SAND, F-C, SILTY, CLAYEY, ORGANICS, LOOSE, SAT., WOOD, BLK. (ALLUV.)

710 — 1 — 105.9 — 117 — 60

CLAY, ORGANICS, SILTY, SOFT, MOIST, PLANT MATTER, SHELLS, BLK.

OH — SILT, ORGANICS, CLAYEY, V. SOFT, SPONGY, SAT., SHELLS, BLK. BRN.

7 — ML — SILT, CLAYEY, SANDY, ORGANICS, M. STIFF, WET-SAT., GRAY BLK.

700 — 2

SAND, ORGANICS, SILTY, LOOSE, SAT., SPONGY, SHELLS, PLANT MATTER, BLK. & BRN.

SP — SAND, F-C, SILTY, LOOSE-M. DENSE., SAT., INTERBEDDED, TR. GRAVEL, TAN BRN.

7

690 — 15

12 — 0.19

CLAY, SILTY, ORGANICS, SOFT-M. STIFF, MOIST-WET, TR. SAND, SHELL FRAGS., PLANT MATTER, GRAY & BLK.
CLAY, ORGANICS, SANDY, SOFT, SAT., SPONGY, SHELLS, PLANT MATTER, BLK. & BRN.
GRAVEL SANDY, SILTY, V. DENSE, SAT., IRON STAINS, BRN.

680 — 18 — 0.12 — SP-SM — SAND, SILTY, M. DENSE, SAT., TR. GRAVEL, TAN BRN.

SAND, F-C, SILTY, M. DENSE, SAT., IRON STAINS, TR. GRAVEL, ORANGE-TAN BRN.

16 — CH SEAM

(4)

670 — 27 — 689.2

SAND, M-C, SILTY, M. DENSE, SAT., GRN. TAN

660

650

640

HR. WITH:

ING DOWNHOLE WHILE MEASURING
PLE WAS CONTAINED IN A BAG AND
SSIBLY METHANE.
STABILIZED WITH DRILLING MUD

PLES TAKEN FROM AN OFFSET HOLE.
MENT-BENTONITE GROUT.

NOTES

1. WATER LEVEL DETERMINED AFTER 1 HR. WITH:
   BOTTOM OF HSA AT EL. 709.2'
   BOTTOM OF HOLE AT EL. 709.3'
   AFTER SAMPLING TO EL. 709.2'.
2. HSA ADVANCED TO EL. 705.2'. HOLE STABILIZED WITH DRILLING MUD BELOW EL. 705.2'.
3. HOLE BACKFILLED WITH TREMIED CEMENT-BENTONITE GROUT.

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

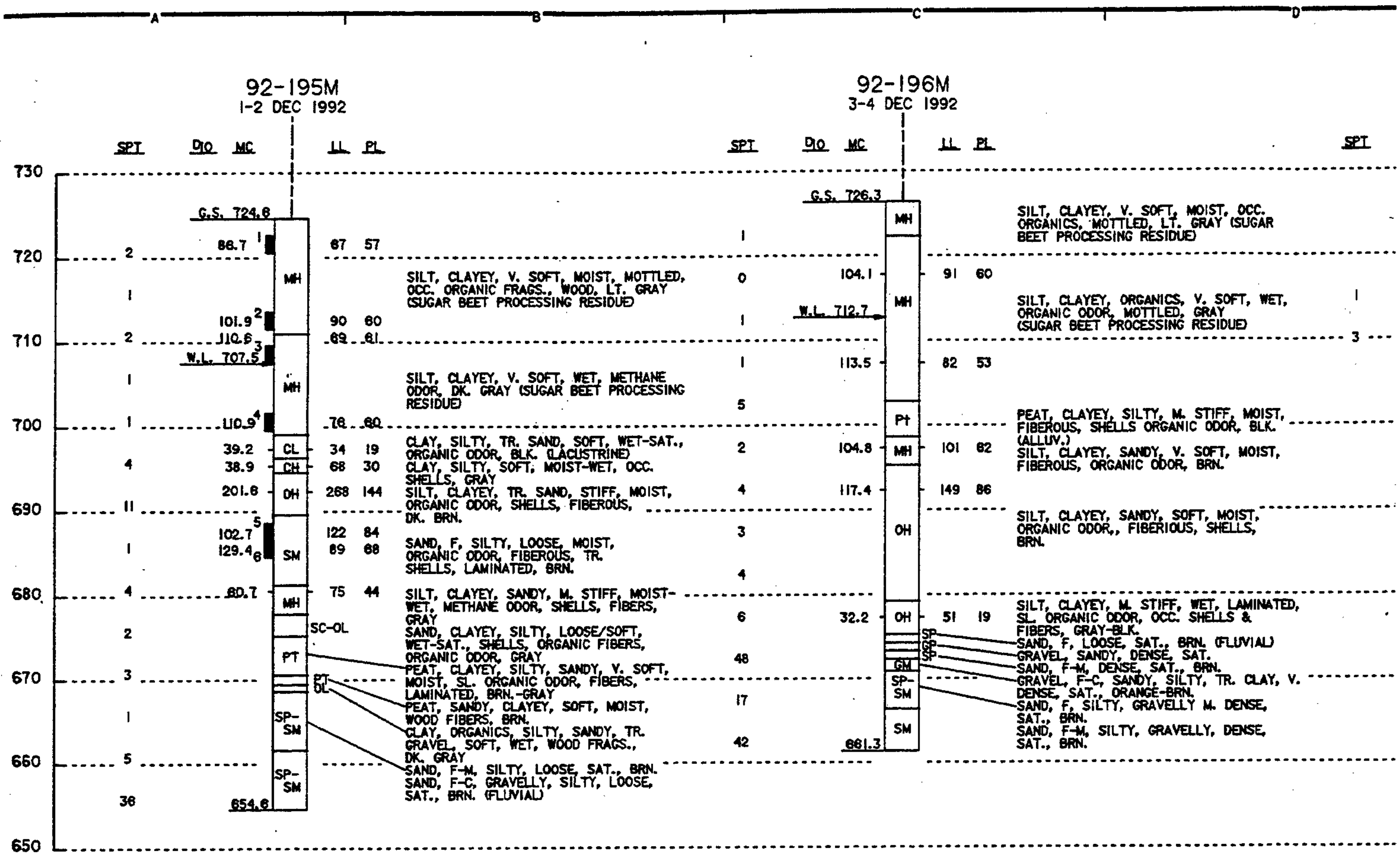
DESIGN MEMORANDUM
CHASKA - STAGE 3
FLOOD CONTROL - EAST CREEK
CHASKA PROJECT CHASKA, MINNESOTA

GEOLOGICAL DATA
BORING LOGS
92-172M THRU 92-174M

DESIGNED:
CHECKED:
DRAWN:
DESIGNED: LJL/PAW
CHECKED: CWB/JRC
DATE: OCTOBER 1993

CAD FILE NAME: CHS3SHIO.DGN
SPEC NO: DACW37-90-B-0000
DRAWING NUMBER: PLATE D-13
SHT 13 OF 16

(9)



NOTES

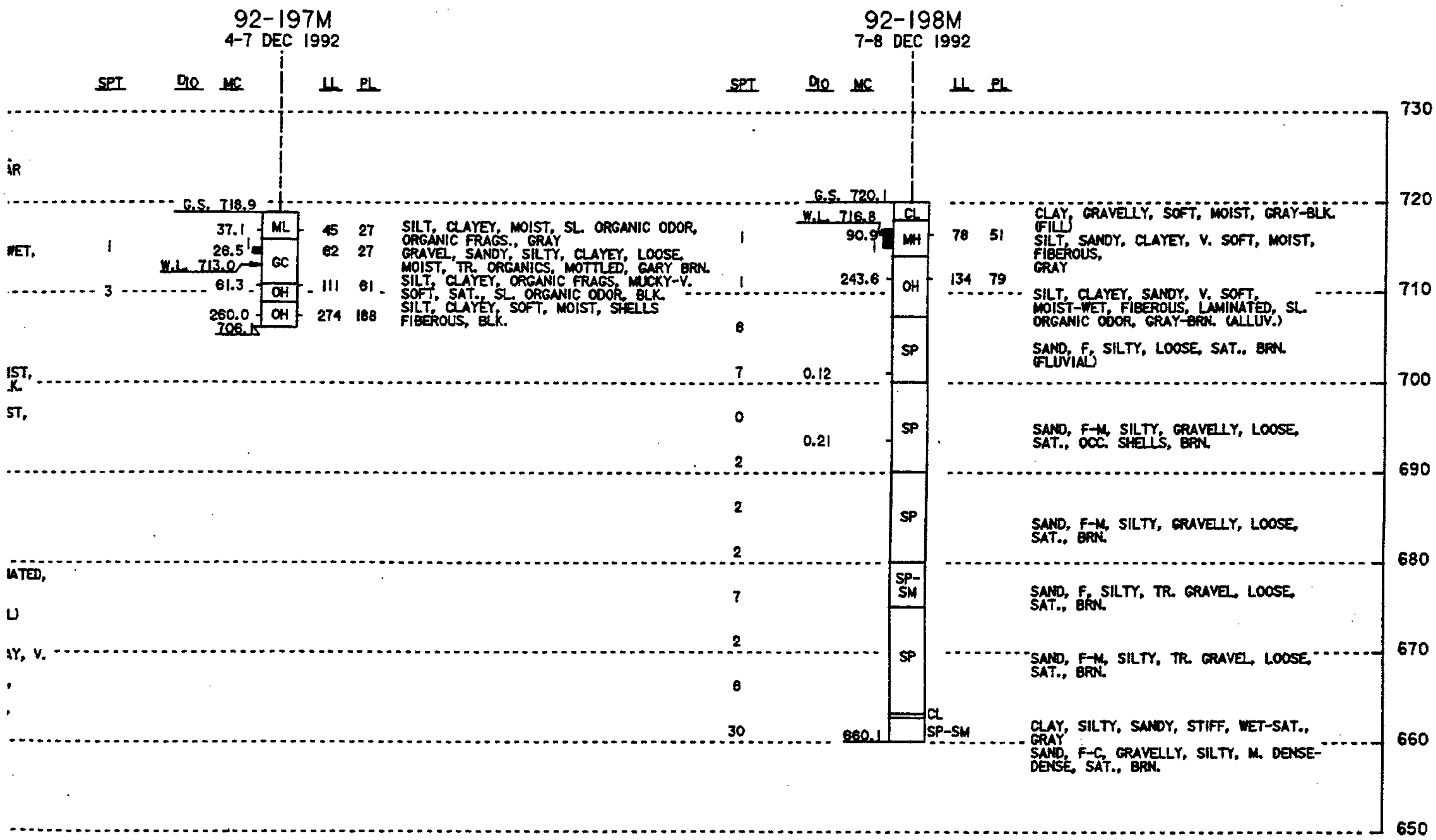
1. WATER LEVEL DETERMINED AFTER 15 HOURS:
   BOTTOM OF AUGER AT EL. 699.6
   BOTTOM OF HOLE AT EL. 698.2
   AFTER SAMPLING TO EL. 694.6.
2. HOLLOW STEM AUGER ADVANCED TO EL. 665.6. HOLE STABILIZED WITH DRILLING MUD BELOW EL. 665.6.
3. APPROX 4 GPM WATER LOSS BETWEEN EL. 664.6 AND EL. 659.4.
4. SIX 5" UNDISTURBED PISTON SAMPLES TAKEN FROM AN OFFSET HOLE.
5. BOTH HOLES BACKFILLED WITH TREMIED CEMENT-BENTONITE GROUT.

NOTES

1. WATER LEVEL DETERMINED AFTER 1.5 HOURS:
   BOTTOM OF AUGER AT EL. 706.3
   BOTTOM OF HOLE AT EL. 702.3
   AFTER SAMPLING TO EL. 701.3.
2. HOLLOW STEM AUGER ADVANCED TO EL. 672.3. HOLE STABILIZED WITH DRILLING MUD BELOW EL. 672.3.
3. SAND HEAVED IN AUGER TO EL. 679.3 AFTER SAMPLING TO EL. 671.3.
4. SAND HEAVED IN HOLE TO EL. 664.5 AFTER SAMPLING TO EL. 663.3.
5. SPT VALUE BETWEEN EL. 662.8 AND EL. 661.8 MAY BE INACCURATE DUE TO HEAVING SAND.
6. HOLE BACKFILLED WITH TREMIED CEMENT-BENTONITE GROUT.

NOTES

1. WA
2. HO
3. ON
4. DR
5. HO



NOTES

1. WATER LEVEL DETERMINED AFTER 2 ½ DAYS:
   BOTTOM OF AUGER AT EL. 713.9
   BOTTOM OF HOLE AT EL. 711.9
   AFTER SAMPLING TO EL. 708.9.
2. HOLE ABANDONED AFTER ENCOUNTERING HARD OBJECT AT EL. 706.1.
3. ONE 5" UNDISTURBED PISTON SAMPLE TAKEN FROM AN OFFSET HOLE. 0.6' RECOVERY DUE TO SAMPLER BLOCKAGE.
4. DRILLER NOTES STANDING WATER IN BOTTOM OF OFFSET HOLE AT EL. 714.3.
5. HOLES BACKFILLED WITH BENTONITE CHIPS, LOCAL SOILS, AND CEMENT-BENTONITE GROUT.

NOTES

1. WATER LEVEL DETERMINED AFTER 1 HOUR:
   BOTTOM OF AUGER AT EL. 717.1
   BOTTOM OF HOLE AT EL. 715.1
   AFTER SAMPLING TO EL. 715.1.
2. HOLLOW STEM AUGER ADVANCED TO EL. 701.1. SAND HEAVED TO EL. 708.2 WITH BOTTOM OF AUGER AT EL. 700.1 HOLE STABILIZED WITH DRILLING MUD BELOW EL. 701.1.
3. SAND HEAVED INTO HOLE TO EL. 663.6 AFTER SAMPLING TO EL. 662.1.
4. ONE 5" UNDISTURBED PISTON SAMPLE TAKEN FROM AN OFFSET HOLE.
5. BOTH HOLES BACKFILLED WITH TREMMIED CEMENT-BENTONITE GROUT.

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

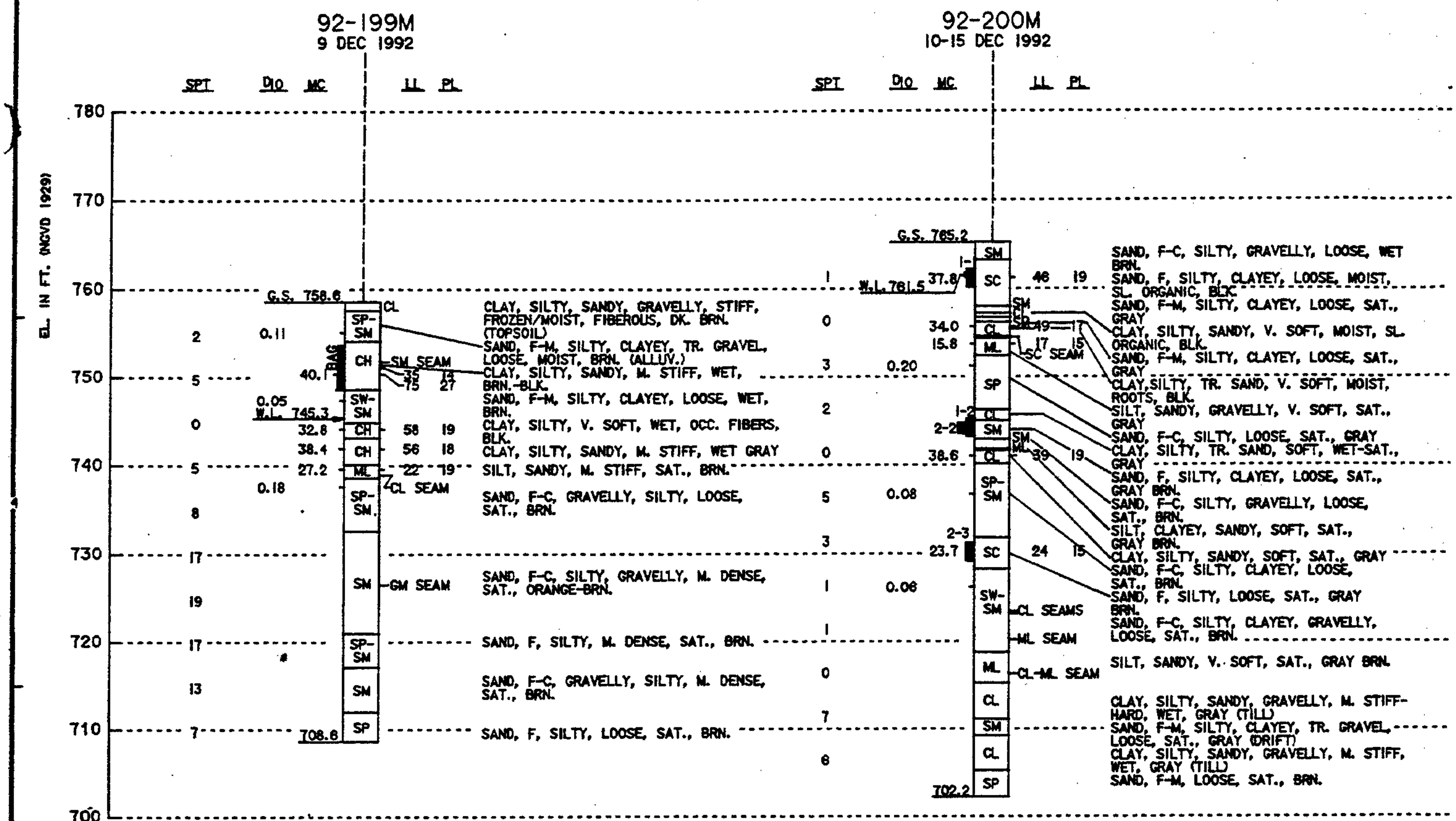
DESIGN MEMORANDUM
CHASKA - STAGE 3
FLOOD CONTROL - EAST CREEK
CHASKA PROJECT CHASKA, MINNESOTA

GEOLOGICAL DATA
BORING LOGS
92-195M THRU 92-198M

DESIGNED:
CHECKED:
DRAWN:
DESIGNED: LJL/PAW
CHECKED: CWB/JRC
DATE: OCTOBER 1993

CAD FILE NAME: CHS3SHLDGN
SPEC NO: DACW37-90-B-0000
DRAWING NUMBER: PLATE D-14
SHT 14 OF 16

(2)

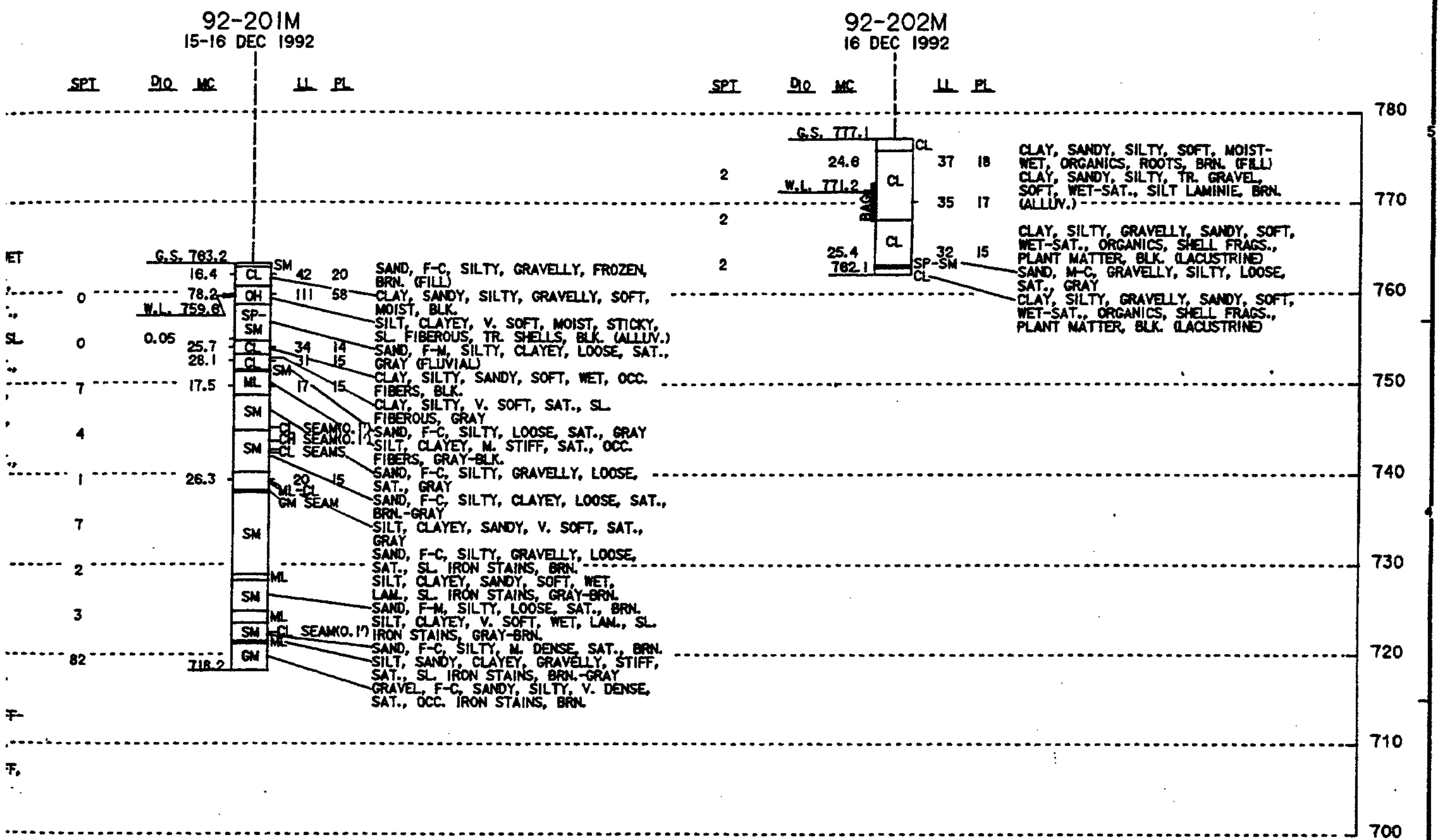


NOTES

1. WATER LEVEL DETERMINED AFTER 2 HOURS:
   BOTTOM OF AUGER AT EL. 743.6
   BOTTOM OF HOLE AT EL. 738.6
   AFTER SAMPLING TO EL. 738.6
2. SAND HEAVED TO EL. 743.6 AFTER ADVANCING HOLLOW STEM AUGER TO EL. 738.6. RESET AUGER TO EL. 739.6. HOLE STABILIZED WITH DRILLING MUD BELOW EL. 739.6 TO EL. 708.6.
3. HOLE BACKFILLED WITH TREMIED CEMENT-BENTONITE GROUT.

NOTES

1. WATER LEVEL DETERMINED AFTER 45 MINUTES:
   BOTTOM OF AUGER AT EL. 760.2
   BOTTOM OF HOLE AT EL. 758.6
   AFTER SAMPLING TO EL. 755.2.
2. HOLLOW STEM AUGER ADVANCED TO EL 750.2. SAND HEAVED TO EL. 753.2 AFTER SAMPLING TO EL. 747.2. RESET AUGER TO EL. 750.7. HOLE STABILIZED WITH DRILLING MUD BELOW EL. 750.7.
3. AUGER ADVANCED TO EL. 741.2 AFTER SAMPLING TO EL. 730.2. SAND HEAVE ENCOUNTERED AFTER SAMPLING TO EL. 715.2.
4. ARTESIAN CONDITIONS ENCOUNTERED BELOW EL. 705.2. ARTESIAN HEAD MEASURED 14 FEET ABOVE GROUND SURFACE AFTER SAMPLING TO EL. 702.2.
5. THREE 5" UNDISUTRBED PISTON SAMPLES TAKEN FROM TWO OFFSET HOLES.
6. ALL HOLES BACKFILLED WITH TREMIED CEMENT-BENTONITE GROUT.



NOTES

1. WATER LEVEL DETERMINED AFTER 50 MINUTES:
   BOTTOM OF AUGER AT EL. 758.2
   BOTTOM OF HOLE AT EL. 758.3
   AFTER SAMPLING TO EL. 753.2.
2. HOLLOW STEM AUGER ADVANCED TO EL. 754.2. HOLE STABILIZED WITH DRILLING MUD BELOW EL. 754.2.
3. HOLE BACKFILLED WITH TREMIED CEMENT-BENTONITE GROUT.

NOTES

1. WATER LEVEL DETERMINED AFTER 50 MINUTES:
   BOTTOM OF AUGER AT EL. 772.1
   BOTTOM OF HOLE AT EL. 769.9
   AFTER SAMPLING TO EL. 767.1
2. HOLLOW STEM AUGER ADVANCED TO EL. 766.8.
3. HOLE BACKFILLED WITH LOCAL SOILS AND BENTONITE CHIPS.

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

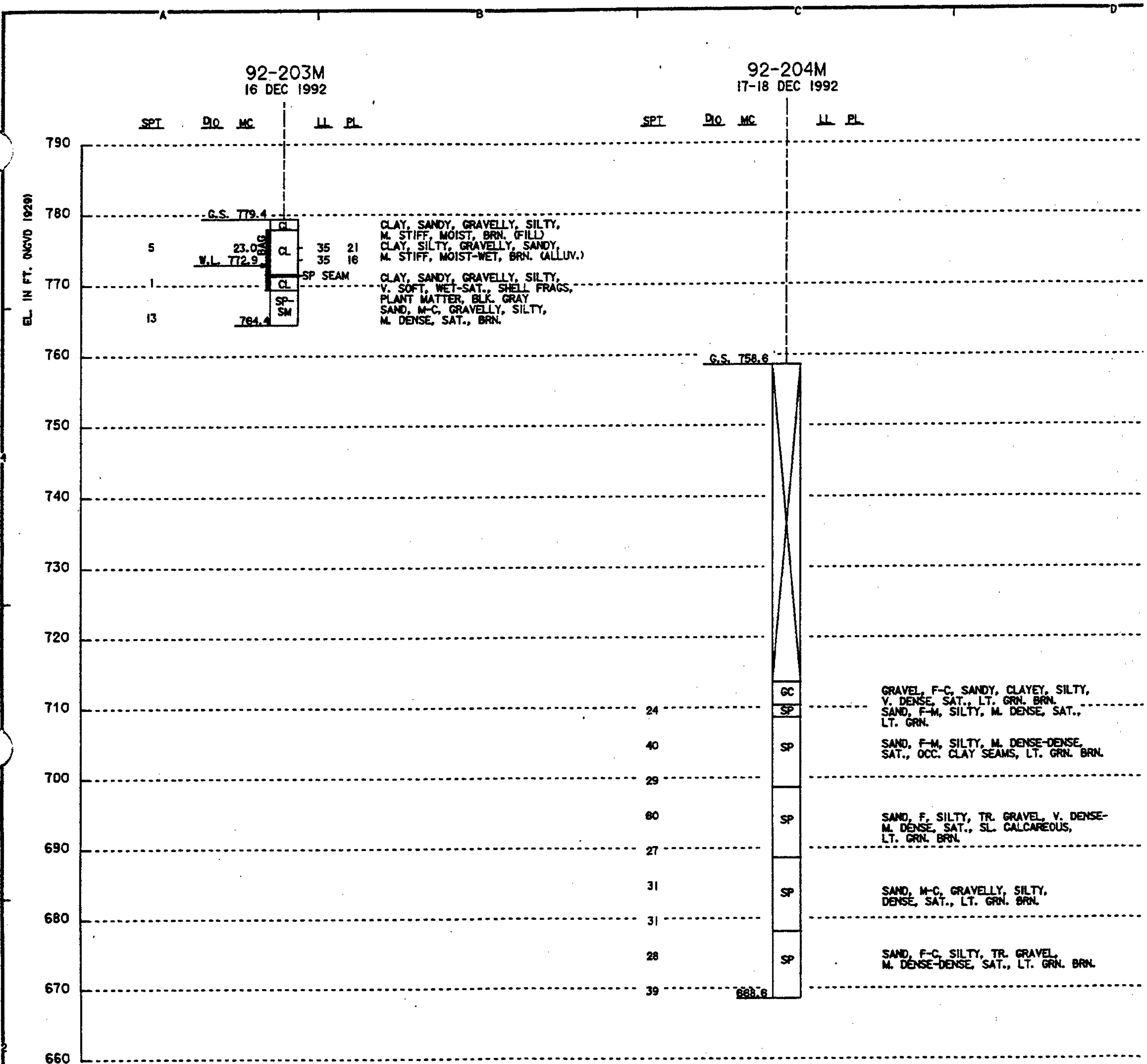
AE APPROVING OFFICIAL:

DESIGN MEMORANDUM
CHASKA - STAGE 3
FLOOD CONTROL - EAST CREEK
CHASKA PROJECT — CHASKA, MINNESOTA

GEOLOGICAL DATA
BORING LOGS
92-199M THRU 92-202M

DESIGNED:
CHECKED:
DRAWN:
DESIGNED: LJL/PAW
CHECKED: CWB/JRC
DATE: OCTOBER 1993
CAD FILE NAME: CHS3SH12.DGN
SPEC NO: DACW37-90-B-0000
DRAWING NUMBER: PLATE D-15
SHT 15 OF 16

2



NOTES

1. WATER LEVEL DETERMINED AFTER 35 MINUTES:
   BOTTOM OF AUGER AT EL. 774.4
   BOTTOM OF HOLE AT EL. 769.7
   AFTER SAMPLING TO EL. 769.4.
2. HOLLOW STEM AUGER ADVANCED TO EL. 769.4.
3. HOLE BACKFILLED WITH LOCAL SOILS AND BENTONITE CHIPS.

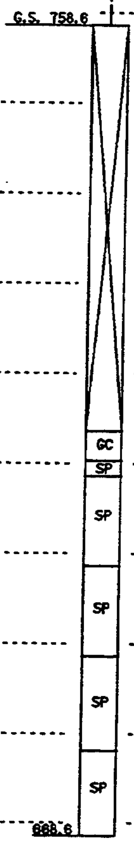
NOTES

1. WATER LEVEL NOT DETERMINED.
2. SET 4" BLACK IRON CASING TO EL. 741.1. DRILLED-OUT TO EL. 713.6. USING MUD-ROTARY METHODS. HOLE STABILIZED WITH DRILLING MUD BELOW EL. 713.6.
3. PARTIAL WATER LOSS BETWEEN EL. 733.6 AND EL. 713.6. SAND HEAVED INTO HOLE BETWEEN EL. 703.6 AND EL. 698.6.
4. HOLE BACKFILLED WITH TREMIED CEMENT-BENTONITE GROUT.
5. BORING IS LOCATED ADJACENT TO 92-199M.

92-204M
17-18 DEC 1992

SPT D10 MC LL PL

G.S. 758.6



24 — GRAVEL, F-C, SANDY, CLAYEY, SILTY, V. DENSE, SAT., LT. GRN. BRN.

SAND, F-M, SILTY, M. DENSE, SAT., LT. GRN.

40 — SAND, F-M, SILTY, M. DENSE-DENSE, SAT., OCC. CLAY SEAMS, LT. GRN. BRN.

29

60 — SAND, F, SILTY, TR. GRAVEL, V. DENSE-M. DENSE, SAT., SL. CALCAREOUS, LT. GRN. BRN.

27

31 — SAND, M-C, GRAVELLY, SILTY, DENSE, SAT., LT. GRN. BRN.

31

28 — SAND, F-C, SILTY, TR. GRAVEL, M. DENSE-DENSE, SAT., LT. GRN. BRN.

39 — 698.6

NOTES

1. WATER LEVEL NOT DETERMINED.
2. SET 4" BLACK IRON CASING TO EL. 741.1. DRILLED-OUT TO EL. 713.6. USING MUD-ROTARY METHODS. HOLE STABILIZED WITH DRILLING MUD BELOW EL. 713.6.
3. PARTIAL WATER LOSS BETWEEN EL. 733.6 AND EL. 713.6. SAND HEAVED INTO HOLE BETWEEN EL. 703.6 AND EL. 698.6.
4. HOLE BACKFILLED WITH TREMIED CEMENT-BENTONITE GROUT.
5. BORING IS LOCATED ADJACENT TO 92-199M.

SYMBOL
AE APPROVIN
DESIGNED
CHECKED:
DRAWN:
DESIGNED
CHECKED:
DATE: OCTOB

E F G

790
780
770
760
750
740
730
720
710
700
690
680
670
660

SYMBOL	DESCRIPTION	DATE	APPROVAL

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

AE APPROVING OFFICIAL:

DESIGN MEMORANDUM
CHASKA - STAGE 3
FLOOD CONTROL - EAST CREEK
CHASKA PROJECT CHASKA, MINNESOTA

GEOLOGICAL DATA
BORING LOGS
92-203M THRU 92-204M

ED-D DESIGNED:	
ED-D CHECKED:	
ED-D DRAWN:	
ED-GH DESIGNED:	LJL/PAW
ED-GH CHECKED:	CWB/JRC
DATE:	OCTOBER 1993

CAD FILE NAME: CHS3SH13.DGN	DRAWING NUMBER:	SHT 16
SPEC NO: DACW37-90-B-0000	PLATE D-16	OF 16

(3)

file:/usr4/jrc/chaska/STAGE3/FDM92/fen/drop/altdd1.w20
10-NOV-1993
10:50:22 AM

This spreadsheet used to determine the radius of influence near the first drop structure of the stage 3 channel

---

Determine an amount of drawdown that won't impact the fen.

Using figure 4-23 from the TM, determine the radius of influence.
Plot the range of radius of influence(R) vs. permeability(k)

R=C*(H-hw)*sqrt(k)
C=1.5-2.0 for line of wellpoints, 3 for wells(according to TM)
Note that a value of C=3 is appropriate if D10 permeabilities used

C	3	3	3	3	
H(ft)	717	717	717	717	
hw(ft)	715	715	715	715	
H-hw(ft)	2	2	2	2	<< 2' drawdown
k(10^-4 cm/sec)	250	500	750	1000	
R(ft)	94.8683	134.164	164.317	189.737	

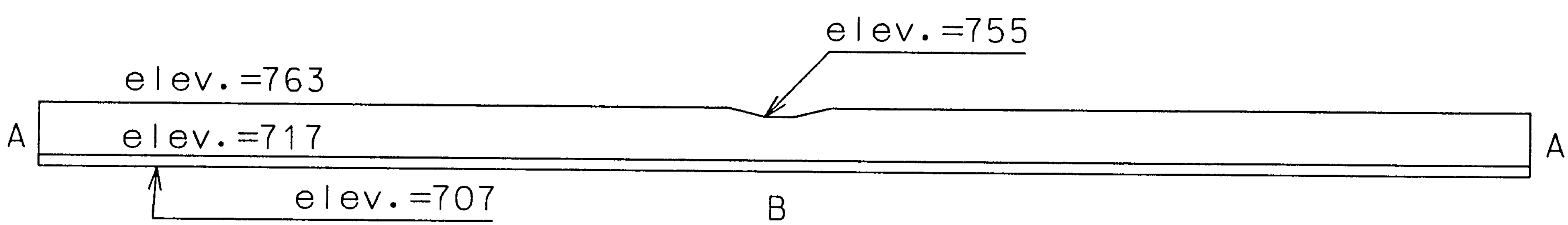
C	3	3	3	3	
H(ft)	717	717	717	717	
hw(ft)	716	716	716	716	
H-hw(ft)	1	1	1	1	<< 1' drawdown
k(10^-4 cm/sec)	250	500	750	1000	
R(ft)	47.4342	67.082	82.1584	94.8683	

C	3	3	3	3	
H(ft)	717	717	717	717	
hw(ft)	716.5	716.5	716.5	716.5	
H-hw(ft)	0.5	0.5	0.5	0.5	<< 1/2' drawdown
k(10^-4 cm/sec)	250	500	750	1000	
R(ft)	23.7171	33.541	41.0792	47.4342	

Summary
A drawdown of less than 1/2 foot should no effect on the fen.
A drawdown of less than 2 feet should have minimal effect on the fen.

....

F.E. Analysis at Engler and Highway 17



Boundary Conditions used:

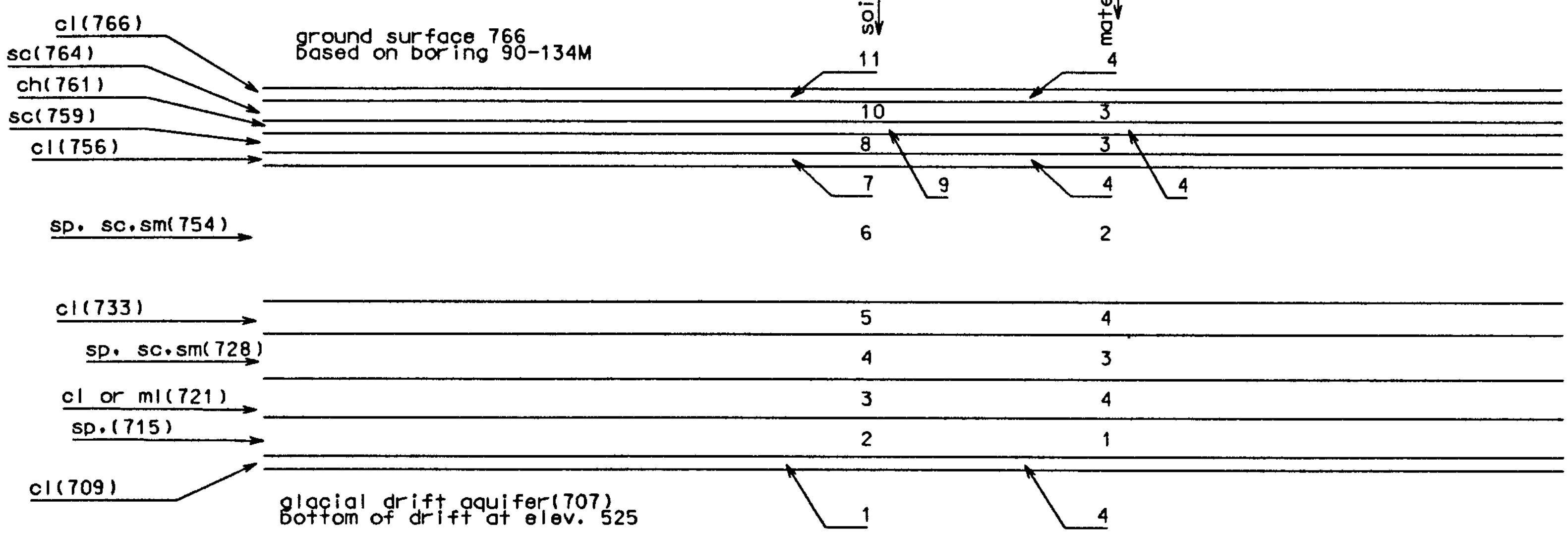
For jrc profile(bottom elev. 707):

Artesian pressure case:
side A - varying from 780 @ elev. 707 to 763 @ elev. 763
based on permeabilities of soil layers
side B - 780

No artesian pressure:
side A - 763
side B - 763

file:/usr/jrc/chaska/stage3/seepage/engler/section.dgn
Mar 12, 1993

for finite element analysis

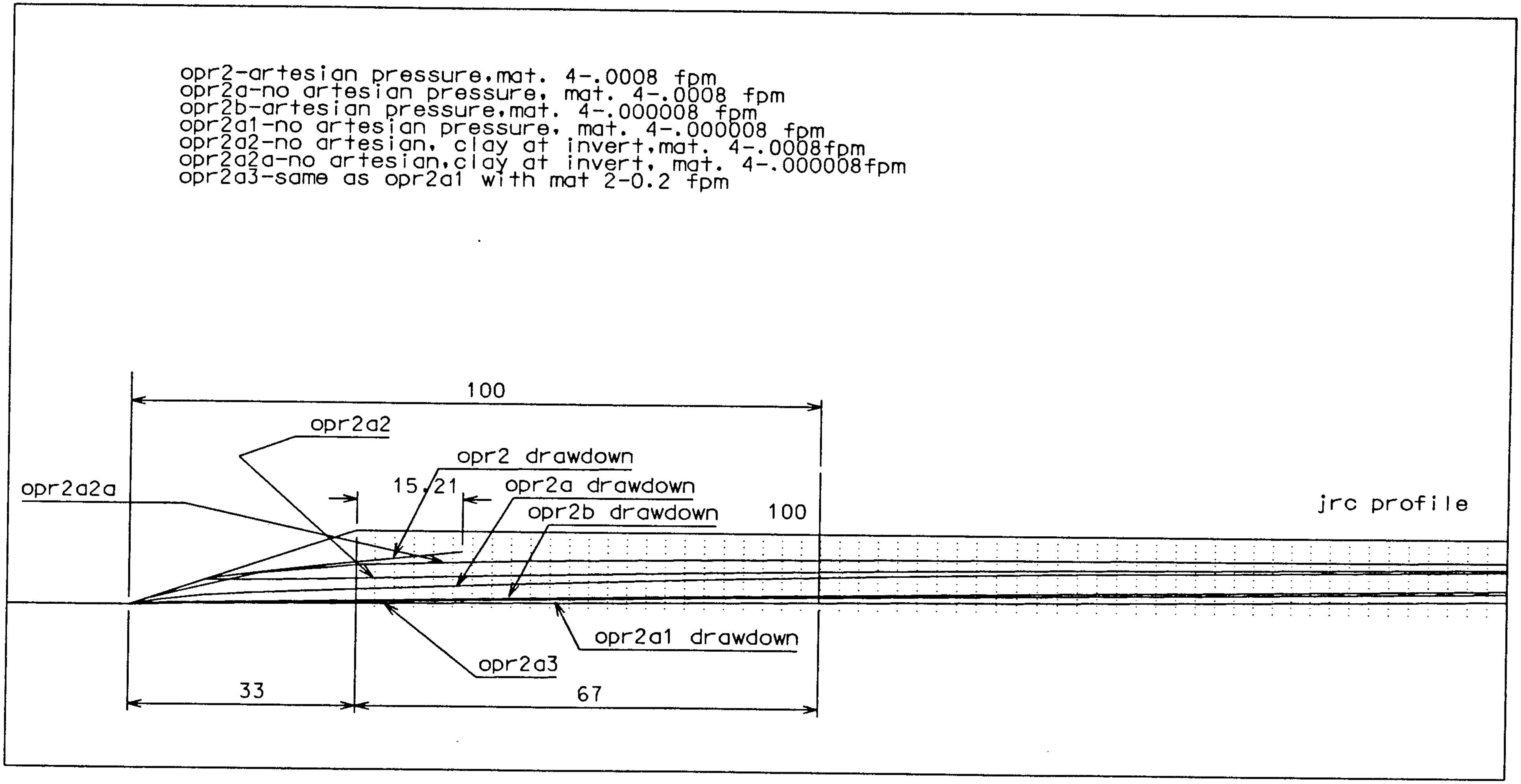


Permeabilities used:
Material 1 - 0.26 ft/min
Material 2 - 0.043 ft/min
Material 3 - 0.001 ft/min
Material 4 - 0.0008 ft/min
Kh=Kv

Permeabilities used:
Material 1 - 0.26 ft/min
Material 2 - 0.043 ft/min
Material 3 - 0.001 ft/min
Material 4 - 0.000008 ft/min
Kh=Kv

Permeabilities used:
Material 1 - 0.26 ft/min
Material 2 - 0.2 ft/min
Material 3 - 0.001 ft/min
Material 4 - 0.000008 ft/min
Kh=Kv

Distance to far fiel from channel c.l. = 645.5'
Far field water level at elev. = 763.0
Drawdown at channel to elev. = 755.0



opr2-artesian pressure.mat. 4-.0008 fpm
opr2a-no artesian pressure, mat. 4-.0008 fpm
opr2b-artesian pressure.mat. 4-.000008 fpm
opr2a1-no artesian pressure, mat. 4-.000008 fpm
opr2a2-no artesian, clay at invert.mat. 4-.0008fpm
opr2a2a-no artesian.clay at invert, mat. 4-.000008fpm
opr2a3-same as opr2a1 with mat 2-0.2 fpm
100
opr2a2
opr2 drawdown
15.21
opr2a2a
opr2a drawdown
opr2b drawdown
100
jrc profile
opr2a1 drawdown
opr2a3
33
67

File :/usr4/cwb/chaska3/uplime/perm/90141m.w20
Project: Chaska Stg. 3

BORING EVALUATION SHEET FOR UPLIFT

Date : 10-NOV-1993

I BOTTOM ELEVATION OF BLANKET : 716.3
II BOTTOM ELEVATION OF AQUIFER : 525.0

Boring log 90-141M
718.9 Top Elev.

Elevation	Depth
718.9	0
708.9	10
698.9	20
688.9	30
678.9	40
668.9	50
658.9	60
648.9	70
638.9	80

III BLANKET EVALUATION

Soil Unit	Elevation From -	To	Thick (z act.)	Kv FPM	Trans. Factor	Zb	Zt	Moist Density	Zt x D
CH	718.9	716.3	2.6	0.0008	1	2.6	2.6	110	286.0
	0		0.0			0	0.0		0.0
			0.0			0	0.0		0.0
			0.0			0	0.0		0.0
			0.0			0	0.0		0.0
			0.0			0	0.0		0.0
			0.0			0	0.0		0.0
			0.0			0	0.0		0.0
			0.0			0	0.0		0.0

Sum "z" = 2.6   2.6   2.6   286.0

Value of Kv to use in calculating X3 below: 0.0008 fpm

IV EVALUATION OF PERVIOUS AQUIFER

Soil Unit	Elevation From -	To	Thick d	D10	Source D10	Kh	Kh x d	Remarks
SP-SM	716.3	712.5	3.8	0.16	G	0.12	0.456	
SP-SC	712.5	711.2	1.3	0.12	A	0.075	0.098	
SP	711.2	708.9	2.3	0.15	G	0.1	0.23	
SP	708.9	698.9	10.0	0.2	G	0.2	2	
SP	698.9	678.9	20.0	0.17	G	0.14	2.8	
SP-SM	678.9	662.6	16.3	0.15	G	0.1	1.63	

Sum [d] = 53.7   Sum [Kh x d] = 7.2

Source : "G" = Gradation, "P" = Permeability Test, "A" = Assumed

Kf = (sum [Kh x d])/(sum [d]) = 0.134 fpm

EQUIVALENT BLANKET LENGTH (X3) (see note below)

(B-3) X3 = [(Kf*d*Zb)/(Kb)]^0.5 = 153.1 ft.

Note: Depending on boundary conditions "X3" may be defined differently.

Chaska Stg. 3
Section @ Sta. 10+00
10-NOV-1993

MATHEMATICAL ANALYSIS OF UNDERSEEPAGE
AND SUBSTRATUM PRESSURE

From Appendix B of "EM 1110-2-1913" & "TM 3-424"

Note : The data from boring evaluation sheet " 90-141M " is used in this spreadsheet.

Case 6, Semipervious Landside Top Stratum and No Riverside Top Stratum.

Input from Boring Evaluation Sheet and cross-section.

```
 Kf =      0.130 fpm of pervious substratum
 Kbl =    0.0008 fpm
 Zt =        2.6 ft.
 Zbl =       2.6 ft.          Landside  cL =  [(Kbl)/(Kf*Zbl*d)]^.5
  d =        198 ft.               "c"  cL =  0.00346
 L2 =         75 ft.                (cL*L3)=  1.03723
 L3 =        300 ft.           tanh(cLL3) =   0.77679
Top of levee =   733.0
Flood elev.  =   731.0  Uplift head =     12.0 ft.
Base of levee =  721.0  Seepage "H" =     10.0 ft.
```

Determine distance from Landside Levee Toe to Effective Seepage Exit, x3.

```
        For L3 = infinity
(B-3)   x3 = 1/cL = [(Kf*Zbl*d)/(Kbl)]^.5
          x3 =     289.2 ft.

        For L3 = finite distance to a seepage block
(B-4)   x3 = 1/(cL*tanh(cLL3))
          x3 =     372.3 ft.

        For L3 = finite dist. to an open seepage exit.
(B-5)   x3 = (tanh(cLL3))/cL
          x3 =     224.7 ft.
```

```
Case 6.      d =     198    L2 =    75.0    x3 = 289.232

 Shape factor "S" = d/(0.43d+L2+x3)  =   0.44062

 Uplift Head  =  ho  =  H*(x3/(0.43d+L2+x3))  =      7.7 ft

Input resisting soil wt. from Boring log sheet. [ SUM (gamma'n x ztn) ]
  Wt. =      165 psf =       2.6 ft. of water    ASSUME gamma sat = 124 pcf

                            2.6
   Factor of Safety =     --------    =       0.34   Min. F.S. > 1.5
                            7.7                      *Berm Required*

  Calculate seepage per ft of levee.     Check Uplift Gradient
   Qs = ($)(Kf)(H)                       Io = ho/Zt  Zt =     2.6 ft.
   Qs =    0.573 ft^3/min/ft.             Io =      2.97
   Qs =    4.285 gpm/ft.

 file : /usr4/cwb/chaska3/uplime/seep/s1000-c6.w20
*Berm Required*
*No Berm Required*
```

File :/usr4/cwb/chaska3/uplime/perm/90137m.w20
Project: Chaska Stg. 3

BORING EVALUATION SHEET FOR UPLIFT

Date : 10-NOV-1993

I BOTTOM ELEVATION OF BLANKET : 722.9
II BOTTOM ELEVATION OF AQUIFER : 525.0

Boring log 90-137M
726.9 Top Elev.

III BLANKET EVALUATION

Elev.	Depth	Soil Unit	Elevation From -	To	Thick (z act.)	Kv FPM	Trans. Factor	Zb	Zt	Moist Density	Zt x D
726.9	0										
		SM	726.9	724.4	2.5	0.002	1	2.5	2.5	112	280.0
		SM	724.4	722.9	1.5	0.002	1	1.5	1.5	112	168.0
716.9	10		0		0.0			0	0.0		0.0
					0.0			0	0.0		0.0
					0.0			0	0.0		0.0
706.9	20				0.0			0	0.0		0.0
					0.0			0	0.0		0.0
					0.0			0	0.0		0.0
696.9	30				0.0			0	0.0		0.0
			Sum "z" =		4.0			4.0	4.0		448.0

Value of Kv to use in calculating X3 below: 0.002 fpm

686.9 40

IV EVALUATION OF PERVIOUS AQUIFER

Elev.	Depth	Soil Unit	Elevation From -	To	Thick d	D10	Source D10	Kh	Kh x d	Remarks
		SP	722.9	714.4	8.5	0.2	G	0.2	1.7	
676.9	50	SP-SM	714.4	703.5	10.9	0.09	G	0.035	0.382	
		SP	703.5	686.9	16.6	0.2	A	0.2	3.32	
			0		0.0				0	
666.9	60				0.0				0	
					0.0				0	

Sum [d] = 36.0 Sum [Kh x d] = 5.4

656.9 70 Source : "G" = Gradation, "P" = Permeability Test, "A" = Assumed

Kf = (sum [Kh x d])/(sum [d]) = 0.15 fpm

EQUIVALENT BLANKET LENGTH (X3) (see note below)

(B-3) X3 = [(Kf*d*Zb)/(Kb)]^0.5 = 103.9 ft.

646.9 80

Note: Depending on boundary conditions "X3" may be defined differently.

MATHEMATICAL ANALYSIS OF UNDERSEEPAGE
AND SUBSTRATUM PRESSURE

Chaska Stg. 3
Section B Sta. 13+50
10-NOV-1993

From Appendix B of "EM 1110-2-1913" & "TM 3-424"

Note : The data from boring evaluation sheet " 90-137M " is used in this spreadsheet.

Case 6, Semipervious Landside Top Stratum and No Riverside Top Stratum.

Input from Boring Evaluation Sheet and cross-section.

```
 Kf =     0.150 fpm of pervious substratum
 Kbl =    0.002 fpm
 Zt =       4.0 ft.
 Zbl =        4 ft.          Landside  cL =  [(Kbl)/(Kf*Zbl*d)]^.5
  d =        36 ft.             "c"    cL =   0.00962
 L2 =        35 ft.                  (cL*L3)= 1.00074
 L3 =       104 ft.          tanh(cLL3) =    0.7619
Top of levee =    734.0
Flood elev.  =    733.0  Uplift head =      4.0 ft.
Base of levee =   730.0  Seepage "H" =      3.0 ft.
```

Determine distance from Landside Levee Toe to Effective Seepage Exit, x3.

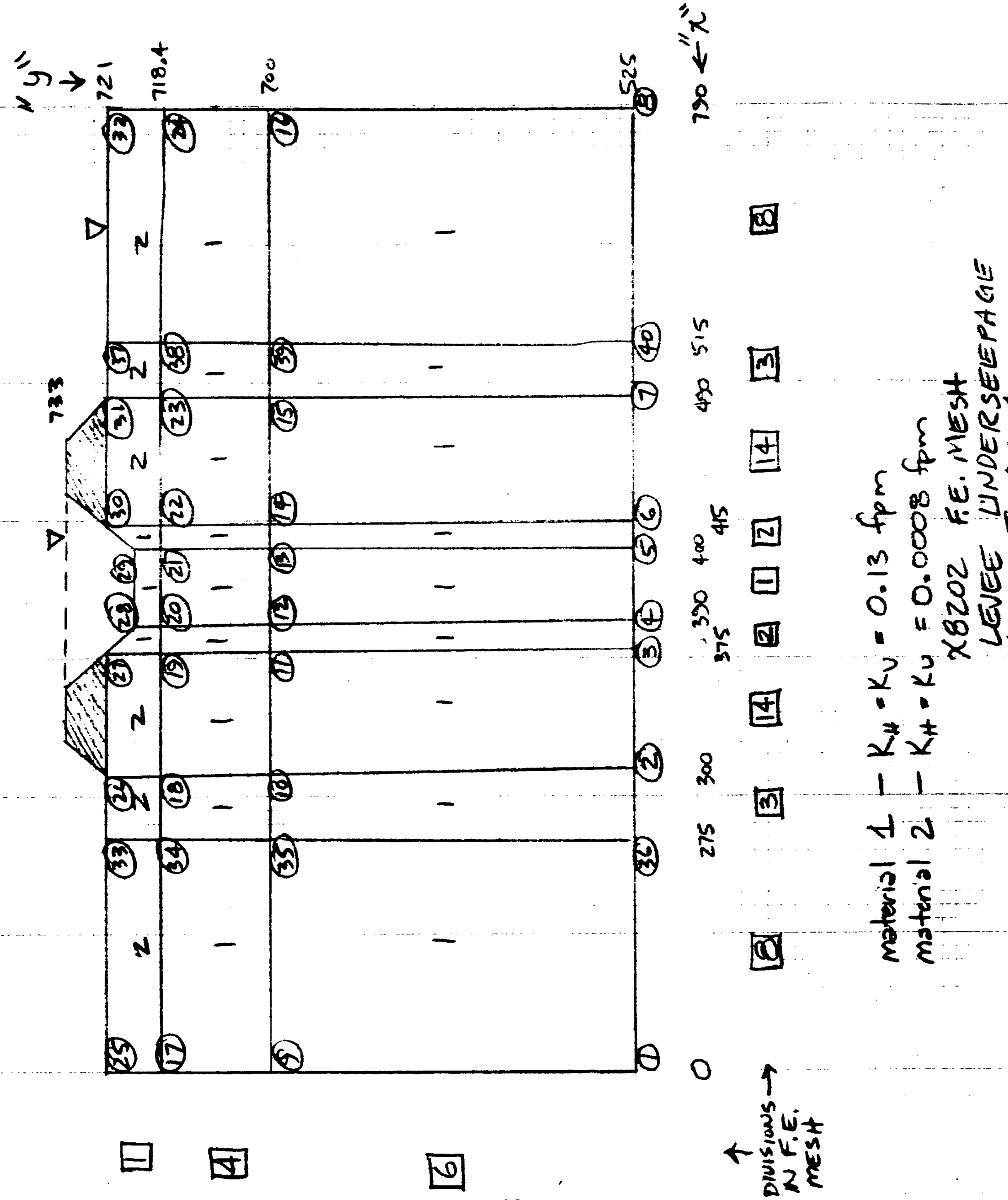
```
       For L3 = infinity
(B-3)  x3 = 1/cL = [(Kf*Zbl*d)/(Kbl)]^.5
         x3 =     103.9 ft.

       For L3 = finite distance to a seepage block
(B-4)  x3 = 1/(cL*tanh(cLL3))
         x3 =     136.4 ft.

       For L3 = finite dist. to an open seepage exit.
(B-5)  x3 = (tanh(cLL3))/cL
         x3 =      79.2 ft.
```

```
Case 6.     d =      36    L2 =    35.0    x3 = 103.923

 Shape factor "$" = d/(0.43d+L2+x3)  =   0.23316

 Uplift Head  =  ho  =  H*(x3/(0.43d+L2+x3))  =      2.7 ft

Input resisting soil wt. from Boring log sheet. [ SUM (gamma'n x ztn) ]
  Wt. =      165 psf =       2.6 ft. of water   ASSUME gamma sat = 124 pcf

                           2.6
   Factor of Safety =   --------   =        0.98   Min. F.S. > 1.5
                           2.7                   *Berm Required*

  Calculate seepage per ft of levee.    Check Uplift Gradient
   Qs = ($)(Kf)(H)                      Io = ho/Zt  Zt =     4.0 ft.
   Qs =     0.105 ft^3/min/ft.           Io =      0.67
   Qs =     0.785 gpm/ft.
```

file : /usr4/cwb/chaska3/uplime/seep/s1350-c6.w20
Berm Required
No Berm Required

NCS 14 (NCS 14, 1 APR 63)

ST. PAUL DISTRICT COMPUTATION SHEET	DATE NOV 10, 1993	PAGE 1 OF 1	FILE NUMBER
NAME OF OFFICE NCS		COMPUTATION F.E. MESH FOR X8202	
SUBJECT CHASKA STAGE 3 UNDERSEEPAGE BETWEEN DS 1 & DS 2		SOURCE DATA	
COMPUTED BY JC	CHECKED BY	APPROVED BY	



file :/usr4/jrc/chaska/STAGE3/FDM92/seepage/engler/bes92201.w20

Project:Chaska Stage 3 BORING EVALUATION SHEET FOR UPLIFT Date : 10-NOV-1993

I BOTTOM ELEVATION OF BLANKET : 758.7

II BOTTOM ELEVATION OF AQUIFER : 754.4

Boring log
763.2 Top Elev.

Elev.	Depth
763.2	0
753.2	10
743.2	20
733.2	30
723.2	40
713.2	50
703.2	60
693.2	70
683.2	80

III BLANKET EVALUATION

Soil Unit	Elevation From -	To	Thick (z act.)	Kv FPM	Trans. Factor	Zb	Zt	Buoyant Density	Zt x D
SM	763.2	762.8	0.4	0.002	0.4	0.16	0.4	57.6	23.0
ML	762.8	760.7	2.1	0.001	0.8	1.68	2.1	47.6	100.0
OL	760.7	758.7	2.0	0.0008	1	2	2.0	47.6	95.2
			0.0			0	0.0		0.0
			0.0			0	0.0		0.0
			0.0			0	0.0		0.0
			0.0			0	0.0		0.0
			0.0			0	0.0		0.0
			0.0			0	0.0		0.0
Sum "z" =			4.5			3.8	4.5		218.2

Value of Kv to use in calculating X3 below: 0.0008 fpm

IV EVALUATION OF PERVIOUS AQUIFER

Soil Unit	Elevation From -	To	Thick d	D10	Source D10	Kh	Kh x d	Remarks
SP-SM	758.7	754.4	4.3	0.05	G	0.004	0.017	
			0.0				0	
			0.0				0	
			0.0				0	
			0.0				0	
			0.0				0	

Sum [d] = 4.3 Sum [Kh x d] = 0.017

Source : "G" = Gradation, "P" = Permeability Test, "A" = Assumed

Kf = (sum [Kh x d])/(sum [d]) = 0.004 fpm

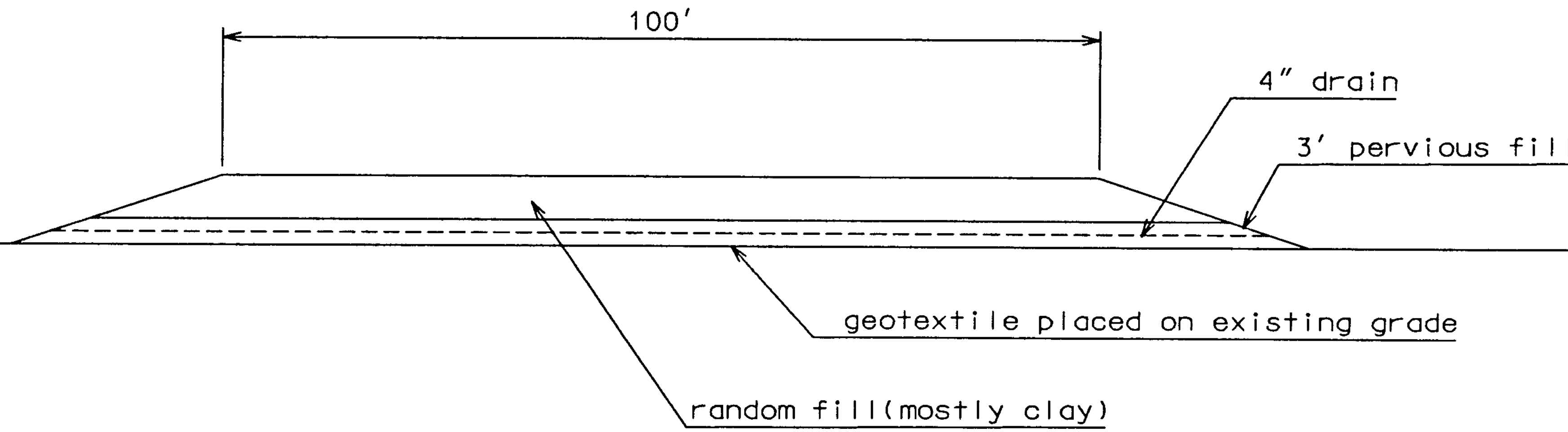
EQUIVALENT BLANKET LENGTH (X3) (see note below)

(B-3) X3 = [(Kf*d*Zb)/(Kb)]^0.5 = 9.086 ft.

Note: Depending on boundary conditions "X3" may be defined differently.

*******end of spreadsheet

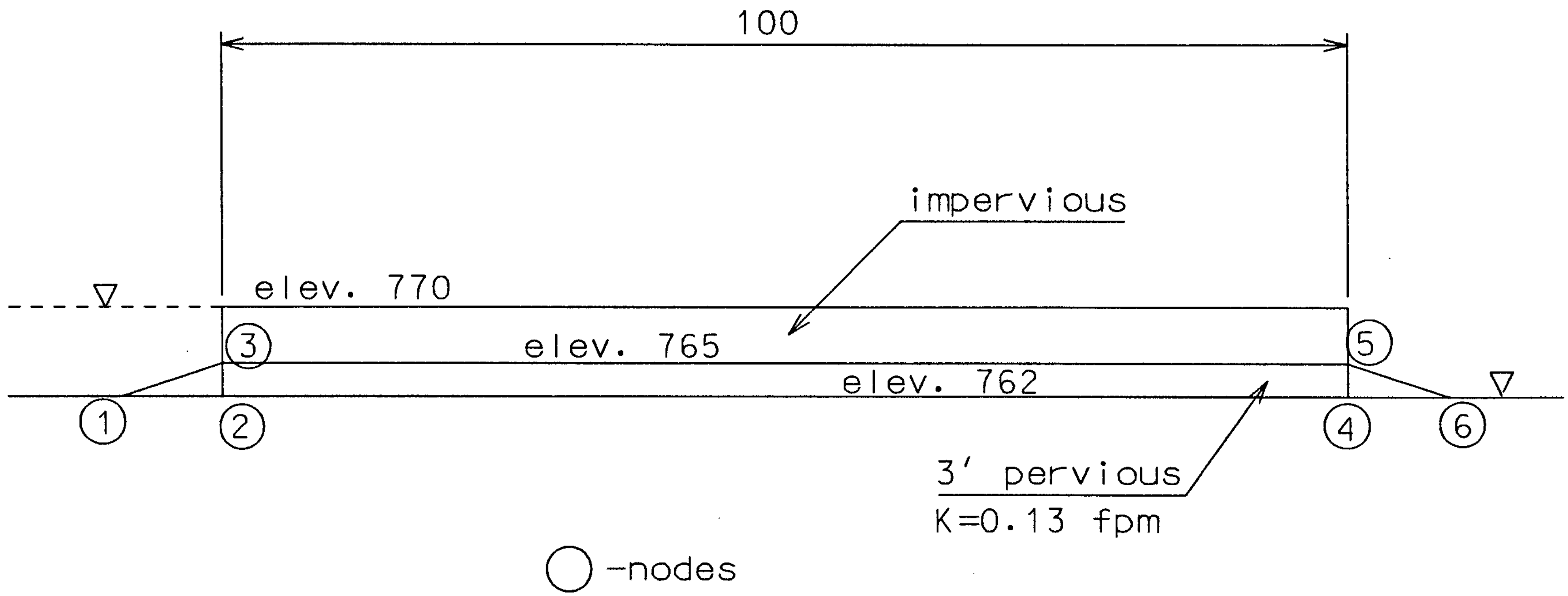
```
file : /usr4/jrc/chaska/STAGE3/FDM92/seepage/engler/sc6-92201.w20
                 MATHEMATICAL ANALYSIS OF UNDERSEEPAGE
                      AND SUBSTRATUM PRESSURE                10-NOV-1993

                 From Appendix B of "EM 1110-2-1913" & "TM 3-424"

Note : The data from boring evaluation sheet "  92-201M" is used in this spreadsheet.

Case 6, Semipervious Landside Top Stratum and No Riverside Top Stratum.
---------------------------------------------------------------------------
Input from Boring Evaluation Sheet and cross-section.

 Kf =     0.004 fpm of pervious substratum
 Kbl =   0.0008 fpm
 Zt =       4.5 ft.
 Zbl =      3.8 ft.           Landside  cL =  [(Kbl)/(Kf*Zbl*d)]^.5
  d =       4.3 ft.               "c"     cL =  0.11063
 L2 =      57.4 ft.                    (cL*L3)= 110.634
 L3 =      1000 ft.              tanh(cLL3) =        1
Top of levee =    768.9
Flood elev.  =    766.4  Uplift head =      7.9 ft.
Base of levee =   761.0  Seepage "H" =      5.4 ft.
---------------------------------------------------------------------------
Determine distance from Landside Levee Toe to Effective Seepage Exit, x3.
        For L3 = infinity
(B-3)   x3 = 1/cL = [(Kf*Zbl*d)/(Kbl)]^.5
          x3 =         9.0 ft.

        For L3 = finite distance to a seepage block
(B-4)   x3 = 1/(cL*tanh(cLL3))
          x3 =         9.0 ft.

        For L3 = finite dist. to an open seepage exit.
(B-5)   x3 = (tanh(cLL3))/cL
          x3 =         9.0 ft.

---------------------------------------------------------------------------
Case 6.      d =      4.3     L2 =     57.4     x3 = 9.03881

 Shape factor "$" = d/(0.43d+L2+x3)  =    0.06297

 Uplift Head  =  ho  =  H*(x3/(0.43d+L2+x3))  =       1.0 ft

Input resisting soil wt. from Boring log sheet.
  Wt. =    218.2 psf =       3.5 ft. of water

                                  3.5
   Factor of Safety =    --------       =        3.34    Min. F.S. > 1.5
                                  1.0                     *No Berm Required*

  Calculate seepage per ft of levee.     Check Uplift Gradient
   Qs = ($)(Kf)(H)                        Io = ho/Zt  Zt =     4.5 ft.
   Qs =     0.001 ft^3/min/ft.              Io =       0.23
   Qs =     0.010 gpm/ft.

*Berm Required*
*No Berm Required*
```



Typical Section- Co. Rd. 17

1V:3H Side Slopes

file: on fdip2b /usr/jrc/chaska/stage3/seepage/hwy17/section.dgn



F.E. Grid- Co. Rd. 17

1V:3H Side Slopes

file: on fdip2b /usr/jrc/chaska/stage3/seepage/hwy17/section.dgn

file:/usr4/jrc/chaska/STAGE3/FDM92/seepage/bes8033a.w20
Project:Chaska Stage 3 BORING EVALUATION SHEET Date : 10-NOV-1993
Outlet E FOR UPLIFT

I BOTTOM ELEVATION OF BLANKET : 765.6
II BOTTOM ELEVATION OF AQUIFER : ?

Boring log
782.0 Top Elev.

III BLANKET EVALUATION

Elev.	Depth	Soil Unit	Elevation From -	To	Thick (z act.)	Kvb FPM	Trans. Factor	Zbl	Zt	Moist Density	Zt x D	Kvr FPM	Trans. Factor	Zbr
782.0	0													
		SW-SM	770	768.2	1.8	0.002	0.3	0.54	1.8	57.6	103.7	0.0014	0.071	0.129
		CL	768.2	765.6	2.6	0.0006	1	2.6	2.6	47.6	123.8	0.0001	1	2.6
772.0	10				0.0			0	0.0		0.0			0
					0.0			0	0.0		0.0			0
					0.0			0	0.0		0.0			0
762.0	20				0.0			0	0.0		0.0			0
					0.0			0	0.0		0.0			0
					0.0			0	0.0		0.0			0
752.0	30				0.0			0	0.0		0.0			0
		Sum "z" =			4.4			3.1	4.4		227.4			2.7

Value of Kv to use in
calculating X3 below: 0.0006 fpm

742.0 40

IV EVALUATION OF PERVIOUS AQUIFER

Elev.	Depth	Soil Unit	Elevation From -	To	Thick d	D10	Source D10	Kh	Kh x d	Remarks
		SC	772	770.9	1.1		A	0	0	
732.0	50	SW-SM	770.9	768.2	2.7	0.088	G	0.04	0.108	
		CL	768.2	765.6	2.6		A	0	0	
		SP	765.6	762	3.6	0.23	G	0.26	0.936	
722.0	60	SP-SM	762	761.4	0.6		A	0.14	0.084	
		GP	761.4	760.2	1.2		A	0.26	0.312	
712.0	70	SP	760.2	758	2.2		A	0.26	0.572	
		GP	758	757	1.0		A	0.26	0.26	
		SP-SM	757	752.3	4.7	0.17	G	0.14	0.658	
		?			0.0				0	
702.0	80									

Sum [d] = 19.7 Sum [Kh x d] = 2.9
Source : "G" = Gradation, "P" = Permeability Test, "A" = Assumed
Kf = (sum [Kh x d])/(sum [d]) = 0.149 fpm

EQUIVALENT BLANKET LENGTH (X3) (see note below)

(B-3) X3 = [(Kf*d*Zb)/(Kb)]^0.5 = 123.8 ft.

Note: Depending on boundary conditions "X3" may be defined differently.

*******end of spreadsheet

file:/usr4/jrc/chaska/STAGE3/FDM92/seepage/sc68033a.w20

MATHEMATICAL ANALYSIS OF UNDERSEEPAGE
AND SUBSTRATUM PRESSURE 10-NOV-1993

From Appendix B of "EM 1110-2-1913" & "TM 3-424"

Note : The data from boring evaluation sheet " 80-33M " is used in this spreadsheet.

Case 6, Semipervious Landside Top Stratum and No Riverside Top Stratum.

Input from Boring Evaluation Sheet and cross-section.

```
 Kf =      0.149 fpm of pervious substratum
 Kbl =    0.0006 fpm
 Zt =        4.4 ft.
 Zbl =       3.1 ft.          Landside  cL =  [(Kbl)/(Kf*Zbl*d)]^.5
  d =       19.7 ft.              "c"    cL =  0.00812
 L2 =        124 ft.                 (cL*L3)= 8.12023
 L3 =       1000 ft.           tanh(cLL3) =        1
Top of levee =    789.0
Flood elev.  =    786.5  Uplift head =     19.0 ft.
Base of levee =   770.0  Seepage "H" =     16.5 ft.
```

Determine distance from Landside Levee Toe to Effective Seepage Exit, x3.

```
        For L3 = infinity
(B-3)   x3 = 1/cL = [(Kf*Zbl*d)/(Kbl)]^.5
          x3 =     123.1 ft.

        For L3 = finite distance to a seepage block
(B-4)   x3 = 1/(cL*tanh(cLL3))
          x3 =     123.1 ft.

        For L3 = finite dist. to an open seepage exit.
(B-5)   x3 = (tanh(cLL3))/cL
          x3 =     123.1 ft.
```

Case 6.   d =   19.7   L2 =   124.0   x3 = 123.149

Shape factor "$" = d/(0.43d+L2+x3) = 0.07707

Uplift Head = ho = H*(x3/(0.43d+L2+x3)) = 9.2 ft

Input resisting soil wt. from Boring log sheet.
Wt. = 227.4 psf = 3.6 ft. of water

```
                        3.6
  Factor of Safety =  --------   =      0.40   Min. F.S. > 1.5
                        9.2                  *Berm Required*
```

```
 Calculate seepage per ft of levee.    Check Uplift Gradient
  Qs = ($)(Kf)(H)                      Io = ho/Zt  Zt =     4.4 ft.
  Qs =    0.189 ft^3/min/ft.             Io =       2.08
  Qs =    1.417 gpm/ft.
```

Berm Required
No Berm Required

file:/usr4/jrc/chaska/STAGE3/FDM92/seepage/bm8033af.w20
10-NOV-1993

SEEPAGE BERM DESIGN - EM 1110-2-1913

```
 i0 =     0.5      Allowable gradient at levee toe
 i1 =     0.8      Allowable gradient at berm toe
 x1 =       0 ft.  Distance to seepage entrance from riverside levee toe
 x3 = 123.149 ft.  Distance to seepage exit from landside levee toe
 L2 =     124 ft.  Levee width
 ho =     9.2 ft.  Head at landside toe of levee without berm
 H  =    19.0 ft.  Total net head on levee
 Kf =   0.149 fpm  Permeability of pervious substratum
Kbl =  0.0006 fpm  Permeability of landside top stratum
Zbl =     3.1 ft.  Transformed thickness of landside top stratum
 Zt =     4.4 ft.  Actual thickness of landside top stratum
 D  =    19.7 ft.  Effective thickness of pervious substratum
 Yt =    52.5 pcf  Submerged unit weight of berm, impervious & semipervious
 Yt =    57.5 pcf  Submerged unit weight of berm, sand & pervious
 Yz =    52.5 pcf  Submerged unit weight of top stratum
 r  =   0.625      i0/i1
 c  = 0.00812      [(Kbl)/(Kf*Zbl*d)]^0.5
 s  =     124 ft.  x1+L2 = dist. to effective seepage entrance from levee toe
 A  =    10.9      6 + 3sc(r+1)
 ha =     3.5 ft.  allowable head at toe of berm = i1*Zt
-----------------------------------------------------------------------
Calculate required berm width, "Xsp" semipervious berm
Xsp =   171.9 ft.  (-A+[A^2-24*(2+r)*(1+s*c-(H/ha))]^.5)/(2c*(2+r))
Calculate head at landside toe of levee with berm
h'o =    11.4 ft.  ha*[1+c*(Xsp)+((2+r)/6)(c*(Xsp))^2]
Calculate required thickness of berm
 t  =     6.2 ft.  (h'o - i0*Zt)/(1+i0)
-----------------------------------------------------------------------
Calculate required berm for: "Xp" pervious berm with collector
 Xp =   118.3 ft.  x3*log(e)(h'o/ha)   h'o=ho
h'o =     9.2 ft.   = ho = (H*x3)/(s+x3)
 t  =     4.4 ft.  [h'o-Zt(Y'z/F*Yw)]/[1+(Y't/F*Yw)     F = 1.6
 Qb =   0.139 cfm  [(Kf*H*d)/(s+x3)]*[1-EXP(-Xp/x3)]
 Qb =    1.04 gpm   flow per ft. of levee
-----------------------------------------------------------------------
Calculate required berm for: "Xs" sand berm
 Xs =   154.1 ft.  (1/3)*(Xp+2Xsp)
h'o =    10.3 ft.  ha*[1+c*Xs+(2+r)/6*(c*Xs)^2]
 t  =     5.1 ft.  [h'o-Zt*(Y'z/F*Yw)]/(1+(Y't/F*Yw))
-----------------------------------------------------------------------
Calculate required berm for: "XI" Impervious berm
 XI =   417.6 ft.  x3*[(H/ha)-1]-s
h'o =    15.5 ft.  H*[(x3+XI)/(s+x3+XI)]
 t  =     8.6 ft.  [h'o-Zt*(Y'z/F*Yw)]/(1+(Y't/F*Yw))
-----------------------------------------------------------------------
```

type of Berm	Width	t	h'o	Thick Berm Crown	Design Slope 1 On	Thick Levee Toe	25 % increase in size Berm Crown	Levee Toe	cu. yd. per 100'	Const. Slope 1 on
Imper	418	8.6	15.5	2.0	75	8.6	2.50	10.8	10,903	51
Semip	172	6.2	11.4	2.0	75	6.2	2.50	7.7	3,575	33
Sand	154	5.1	10.3	2.0	75	5.1	2.50	6.4	2,753	40
P w/C	118	4.4	9.2	2.0	75	4.4	2.50	5.5	1,910	40

file:/usr4/jrc/chaska/STAGE3/FDM92/seepage/bes8033.w20
Project:Chaska Stage 3 BORING EVALUATION SHEET FOR UPLIFT Date : 10-NOV-1993
Outlet E

I BOTTOM ELEVATION OF BLANKET : 772.0
II BOTTOM ELEVATION OF AQUIFER : ?

Boring log
782.0 Top Elev.

Elev.	Depth
782.0	0
772.0	10
762.0	20
752.0	30
742.0	40
732.0	50
722.0	60
712.0	70
702.0	80

III BLANKET EVALUATION

Soil Unit	Elevation From -	To	Thick (z act.)	Kvb FPM	Trans. Factor	Zbl	Zt	Moist Density	Zt x D	Kvr FPM	Trans. Factor	Zbr
SP-SC	782	779	3.0	0.002	0.3	0.9	3.0	57.6	172.8	0.0014	0.071	0.214
SM	779	777	2.0	0.002	0.3	0.6	2.0	57.6	115.2	0.0014	0.071	0.143
CL	777	772	5.0	0.0006	1	5	5.0	47.6	238.0	0.0001	1	5
			0.0			0	0.0		0.0			0
			0.0			0	0.0		0.0			0
			0.0			0	0.0		0.0			0
			0.0			0	0.0		0.0			0
			0.0			0	0.0		0.0			0
			0.0			0	0.0		0.0			0
Sum "z" =			10.0			6.5	10.0		526.0			5.4

Value of Kv to use in
calculating X3 below: 0.0006 fpm

IV EVALUATION OF PERVIOUS AQUIFER

Soil Unit	Elevation From -	To	Thick d	D10	Source D10	Kh	Kh x d	Remarks
SC	772	770.9	1.1		A	0	0	
SW-SM	770.9	768.2	2.7	0.088	G	0.04	0.108	
CL	768.2	765.6	2.6		A	0	0	
SP	765.6	762	3.6	0.23	G	0.26	0.936	
SP-SM	762	761.4	0.6		A	0.14	0.084	
GP	761.4	760.2	1.2		A	0.26	0.312	
SP	760.2	758	2.2		A	0.26	0.572	
GP	758	757	1.0		A	0.26	0.26	
SP-SM	757	752.3	4.7	0.17	G	0.14	0.658	
?			0.0				0	

Sum [d] = 19.7 Sum [Kh x d] = 2.9
Source : "G" = Gradation, "P" = Permeability Test, "A" = Assumed
Kf = (sum [Kh x d])/(sum [d]) = 0.149 fpm

EQUIVALENT BLANKET LENGTH (X3) (see note below)

(B-3) X3 = [(Kf*d*Zb)/(Kb)]^0.5 = 178.2 ft.

Note: Depending on boundary conditions "X3" may be defined differently.

*******end of spreadsheet

file:/usr4/jrc/chaska/STAGE3/FDM92/seepage/sc68033z.w20

MATHEMATICAL ANALYSIS OF UNDERSEEPAGE
AND SUBSTRATUM PRESSURE 10-NOV-1993

From Appendix B of "EM 1110-2-1913" & "TM 3-424"

Note : The data from boring evaluation sheet " 80-33M " is used in this spreadsheet.

Case 6, Semipervious Landside Top Stratum and No Riverside Top Stratum.

Input from Boring Evaluation Sheet and cross-section.

Kf = 0.149 fpm of pervious substratum
Kbl = 0.0006 fpm
Zt = 10.0 ft.
Zbl = 6.5 ft. Landside cL = [(Kbl)/(Kf*Zbl*d)]^.5
d = 19.7 ft. "c" cL = 0.00561
L2 = 43 ft. (cL*L3)= 5.6078
L3 = 1000 ft. tanh(cLL3) = 0.99997
Top of levee = 787.5
Flood elev. = 785.0 Uplift head = 5.5 ft.
Base of levee = 782.0 Seepage "H" = 3.0 ft.

Determine distance from Landside Levee Toe to Effective Seepage Exit, x3.

For L3 = infinity
(B-3) x3 = 1/cL = [(Kf*Zbl*d)/(Kbl)]^.5
x3 = 178.3 ft.

For L3 = finite distance to a seepage block
(B-4) x3 = 1/(cL*tanh(cLL3))
x3 = 178.3 ft.

For L3 = finite dist. to an open seepage exit.
(B-5) x3 = (tanh(cLL3))/cL
x3 = 178.3 ft.

Case 6. d = 19.7 L2 = 43.0 x3 = 178.323

Shape factor "$" = d/(0.43d+L2+x3) = 0.08573

Uplift Head = ho = H*(x3/(0.43d+L2+x3)) = 4.3 ft

Input resisting soil wt. from Boring log sheet.
Wt. = 526 psf = 8.4 ft. of water

Factor of Safety = $\frac{8.4}{4.3}$ = 1.98 Min. F.S. > 1.5
No Berm Required

Calculate seepage per ft of levee.
Qs = ($)(Kf)(H)
Qs = 0.038 ft^3/min/ft.
Qs = 0.287 gpm/ft.

Check Uplift Gradient
Io = ho/Zt Zt = 10.0 ft.
Io = 0.43

Berm Required
No Berm Required

****

excerpt from file:/usr4/jrc/chaska/STAGE3/FDM92/seepage/creep.w20
18-NOV-1993 10:50:27 AM
Creep
Creep path distances from microstation drawing:
on fdip2b, file:/usr/jrc/chaska/stage3/bor/section1.dgn
The microstation drawing generated from coordinates listed above.
The d.w.s. elev. will be at u.s. and d.s. structure curbs, if available.
If difference between u.s. & d.s. curb elev. > d.w.s., that will contol design
Creep path will not include riprap thicknesses.
The design min. creep ratio is 7, assumes fine sand for fndt. materials.

....

Drop structure 1

Lane's "weighted" creep ratio
Cw=((H/3)+(V+Vs))/h

Cw	H ft	V ft	Vs ft	h ft	
4.7	42.7	7.2	0	4.6	existing structure, design water surface shows creep path may be problem
5.9	42.7	12.95	0	4.6	existing structure, design water surface with riprap included
6.2	42.7	7.2	7	4.6	planned design

....

Drop structure 2

Lane's "weighted" creep ratio
Cw=((H/3)+(V+Vs))/h

Cw	H ft	V ft	Vs ft	h ft	
2.3	62.6	20.8	0	17.9	existing structure, design water surface shows creep path may be problem
2.6	62.6	26.55	0	17.9	existing structure, design water surface with riprap included
3.0	62.6	20.8	12.74	17.9	planned design

....

Drop structure 3

Lane's "weighted" creep ratio
Cw=((H/3)+(V+Vs))/h

Cw	H ft	V ft	Vs ft	h ft	
2.9	49.25	12.4	0	10	existing structure, difference in curb elevations shows creep path may be problem
3.5	49.25	18.15	0	10	existing structure, difference in curb elevations with riprap included
3.8	49.25	12.4	8.8	10	planned design

....

Drop structure 4

Lane's "weighted" creep ratio
Cw=((H/3)+(V+Vs))/h

Cw	H ft	V ft	Vs ft	h ft	
2.5	49.25	15.5	0	12.8	existing structure, difference in curb elevations shows creep path may be problem
2.9	49.25	21.25	0	12.8	existing structure, difference in curb elevations with riprap included
2.9	49.25	15.5	5.6	12.8	planned design

....

Bligh's creep ratio

C=L/h

C	L	h
0	0	1

TM 3-424
page 61
Table 2

MINIMUM CREEP RATIOS

Material	Creep ratios Bligh C	Lane Cw
very fine sand or silt	18	8.5
fine sand	15	7
medium sand	--	6
coarse sand	12	5
fine gravel or sand and gravel	9	4
coarse gravel including cobbles	4 to 6	3
boulders with some cobbles and gravel	--	2.5

from table 5.2 , pg 126
Groundwater and Seepage
by Milton E. Harr
(Neil's book)

Recommended Weighted Creep Ratio's(Lane)

Material	Safe weighted creep-head ratios,Rc Lane Cw
very fine sand or silt	8.5
fine sand	7
medium sand	6
coarse sand	5
fine gravel	4
medium gravel	3.5
coarse gravel,including cobbles	3
boulders with some cobbles and gravel	2.5
soft clay	3
medium clay	2
hard clay	1.8
very hard clay or hardpan	1.6

```
*************************************************************************************************************
exerpt from file:/usr4/jrc/chaska/STAGE3/FDM92/seepage/creep.w20

CFRAG input files

Assumes bottom of pervious stratum at elev. 525 unless otherwise noted.
Uses max. design water surface for uplift pressures.
Uses difference in curb elevations for gradient if greater than the
  difference in design water surface elevations.
Corrected for nonisotropic permeabilities(see pg. 20 instruction man.
Using highest permeability at any structure location.
Files on fdip2b in /usr/jrc/chaska/stage3/seepage/
Files are ds1, ds2, etc. for drop structure 1 or 2, etc.
Output are in files ds1.o, ds2.o, etc.
Assumes riprap has no effect on flow.
..........................................................................................

final d.s. 4 wingwalls
100     name d.s. 4 ww w/3.5's.d.,18.15's.p.
110     units ft min                                   note 20' sheetpile cuts off flow
120       water   0.024    19.75    12.8     L         (k from D10=0.08 mm)
130       frag      2      27.75    13.35
140       frag      6      49.25    33.4     22     19
150       frag      2      16.2      4.8
160        end

transformation factors
    X        Y        K         x         y          Kx      Ky
   0.5       2      0.012       1         1         0.024   0.006

100     name d.s. 4 ww w/3.5's.d.,18.15's.p. , trans. perm.
110     units ft min
120       water   0.012    19.75    12.8     L
130       frag      2      55.5     26.7
140       frag      6      24.625   66.8     44     38
150       frag      2      32.4      9.6
160        end
..........................................................................................
```

file:/usr4/jrc/chaska/STAGE3/FDM92/seepage/cfw4m.w20
10-NOV-1993 01:31:13 PM

reducing CFRAG output

file:name d.s. 4 ww w/3.5's.d.,18.15's.p.
12.8=total head loss

frag no	frag type	L	A	B	T	S1	S2	form fac	head loss
1	2				55.5	26.7		0.97	4.98
2	6	24.63			66.8	44	38	0.79	4.06
3	2				32.4	9.6		0.74	3.77

19.8= head above u.s. grade(from CFRAG input)

see sketch for pressure locations
0.03808=gradient for 2nd fragment

Pa=	1232	63168.7=Lateral force, headwater side
Pc=	2588	
Pd=	126	2396.39=uplift force
Pe=	68.3	
Pf=	2709	
Pg=	1875	50179.4=Lateral force, tailwater side

check exit gradient(pg 19 of CFRAG manual,also page 11)
Ie=(h*pi)/(2*K*T*m)
for type 2 fragments,m=sin((pi*s)/(2*T))
obtain K from table

Ie	h	K	T	m	s	m^2	Ie
0.25	3.77	1.66	32.4	0.4488	9.6	0.20142	0.24533

revising above from transformed section to actual dimensions and pressures

L, T, ,S1, & S2 from pre-input file for file :/w4m.o
12.8=total head loss

frag no	frag type	L	A	B	T	S1	S2	form fac	head loss
1	2				27.75	13.35		0.97	4.98
2	6	49.25			33.4	22	19	0.79	4.06
3	2				16.2	4.8		0.74	3.77

19.8= head above u.s. grade(from CFRAG input)

0.04499=gradient for 2nd fragment

Pa=	1232	32108.8=Lateral force, headwater side
Pc=	1755	
Pd=	516	22011.7=uplift force
Pe=	378	
Pf=	1689	
Pg=	1154	17502.8=Lateral force, tailwater side

Ie	h	K	T	m	s	m^2	Ie
0.49	3.77	1.66	16.2	0.4488	4.8	0.20142	0.49067

file:/usr4/jrc/chaska/STAGE3/FDM92/seepage/cfhelp.w20

10-NOV-1993 01:39:08 PM
rechecked based on GENERALS REVISED safety drop of 3.5' vs 3'
check of revised cutoffs on drop structures based on above info
for help in determining CFRAG input files

for drop structures

	w/3.5' safety drop ds1	ds2	ds3	ds4
u.s.t.l.*upstream top of levee	732.2	753.4	767	784.1
u.s.c.i.*upstream channel invert	715.5	732.5	748.5	766.1
u.s.r.r.*upstream riprap thickness(ft)	1.75	1.75	1.75	1.75
b.o.b. *bottom of basin	709.5	712.7	736.57	750.8
d.s.r.r.*upstream riprap thickness(ft)	4	4	4	4
d.s.c.i.*upstream channel invert	715	720	742	756.8
d.s.t.l.*upstream top of levee	723.8	735.5	758	771.3
b.o.a. *bottom of aquifer	525	525	525	736.6
HDWT	18.45	22.65	20.25	19.75
H	8.4	17.9	10	12.8
S1	4.25	18.05	10.18	13.55
T1	188.75	205.75	221.75	27.75
S2,1	3.5	6.7	4.57	2.8
S2,2	0	0	0	0
T2	184.5	187.7	211.57	14.2
S3	5	10	6	4.8
T3	186	191	213	16.2
bot u.s.*bottom of u.s. sheetpile cutoff	709.5	712.7	736.57	750.8
bot d.s.*bottom of d.s. sheetpile cutoff	706	706	732	748
c.o.l. *total vertical length of cutoff	9.25	28.05	16.18	18.35

Files were adjusted to transformed permeability with Kh=4*Kv

file	ds1fb	ds2fb	ds3fb	ds4fb
I.E.(transformed)	0.2509	0.2412	0.2317	0.2351
I.E.(actual)	0.5018	0.4824	0.4634	0.4702

****

****
excerpt from file:/usr4/jrc/chaska/STAGE3/FDM92/seepage/cfhelp.w20
Recheck wingwalls

09-JUL-1993
rechecked based on GENERALS REVISED safety drop of 3.5' vs 3'
rechecked based on STRUCTURES REVISED bottom of slab elevation
check of revised cutoffs on drop structures based on above info
for help in determining CFRAG input files

for wingwalls

	w/3.5' safety drop			
	ww1	ww2	ww3	ww4
	^^^^^^^	^^^^^^^	^^^^^^^	^^^^^^^
u.s.t.l.*upstream top of levee	732.2	753.4	767	784.1
u.s.c.i.*upstream channel invert	715.5	732.5	748.5	766.1
u.s.r.r.*upstream riprap thickness(ft)	1.75	1.75	1.75	1.75
b.o.b. *bottom of basin	720	730	750	770
d.s.r.r.*upstream riprap thickness(ft)	4	4	4	4
d.s.c.i.*upstream channel invert	715	720	742	756.8
d.s.t.l.*upstream top of levee	723.8	735.5	758	771.3
b.o.a. *bottom of aquifer	525	525	525	736.6
HDWT	18.45	22.65	20.25	19.75
H	8.4	17.9	10	12.8
S1	4.25	14.75	6.75	13.35
T1	188.75	205.75	221.75	27.75
S2,1	14	24	18	22
S2,2	10.5	14	10	19
T2	195	205	225	33.4
S3	5	10	6	4.8
T3	186	191	213	16.2
bot u.s.*bottom of u.s. sheetpile cutoff	709.5	716	740	751
bot d.s.*bottom of d.s. sheetpile cutoff	706	706	732	748
c.o.l. *total vertical length of cutoff	9.25	24.75	12.75	18.15

Files were adjusted to transformed permeability with Kh=4*Kv

file	ww1f	ww2f	ww3f	ww4f
I.E.(transformed)	0.2522	0.2494	0.2429	0.245
I.E.(actual)	0.5044	0.4988	0.4858	0.49

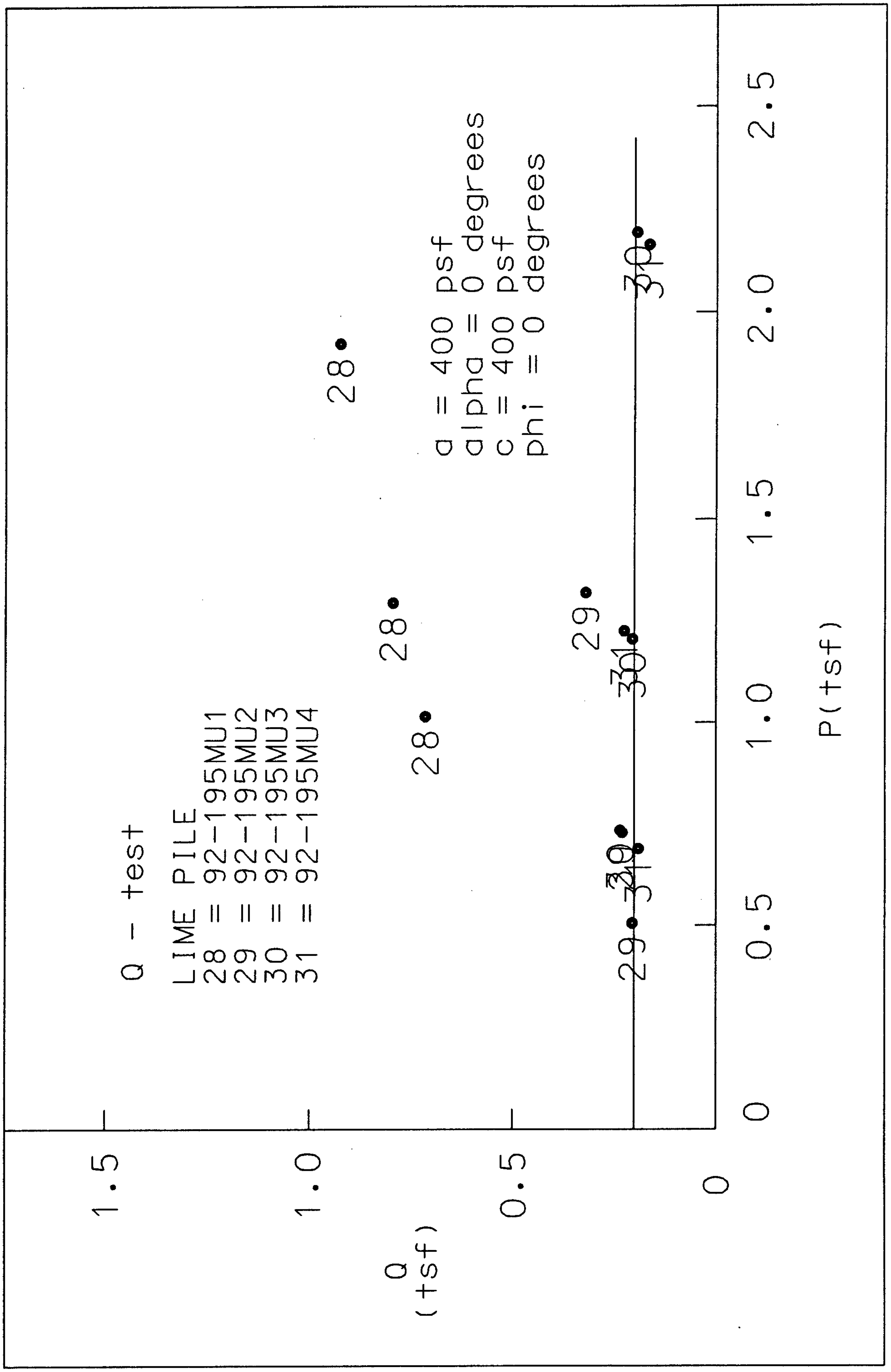
****
exerpt from file:/usr4/jrc/chaska/STAGE3/FDM92/seepage/cfhelp.w20

for help in determining CFRAG input files
summary of files used in wingwall analysis from above
for wingwalls w/o safety drop

	w/o safety drop			
	ww1	ww2	ww3	ww4
	^^^^^^^	^^^^^^^	^^^^^^^	^^^^^^^
u.s.t.l.*upstream top of levee	732.2	753.4	767	784.1
u.s.c.i.*upstream channel invert	719	736	752	769.6
u.s.r.r.*upstream riprap thickness(ft)	1.75	1.75	1.75	1.75
b.o.b. *bottom of basin	720	730	750	770
d.s.r.r.*upstream riprap thickness(ft)	4	4	4	4
d.s.c.i.*upstream channel invert	715	720	742	756.8
d.s.t.l.*upstream top of levee	723.8	735.5	758	771.3
b.o.a. *bottom of aquifer	525	525	525	736.6
HDWT	14.95	19.15	16.75	16.25
H	8.4	17.9	10	12.8
S1	5.25	18.25	10.25	16.85
T1	192.25	209.25	225.25	31.25
S2,1	14	24	18	22
S2,2	8	14	10	19
T2	195	205	225	33.4
S3	5	10	6	4.8
T3	186	191	213	16.2
bot u.s.*bottom of u.s. sheetpile cutoff	712	716	740	751
bot d.s.*bottom of d.s. sheetpile cutoff	706	706	732	748
c.o.l. *total vertical length of cutoff	10.25	28.25	16.25	21.65

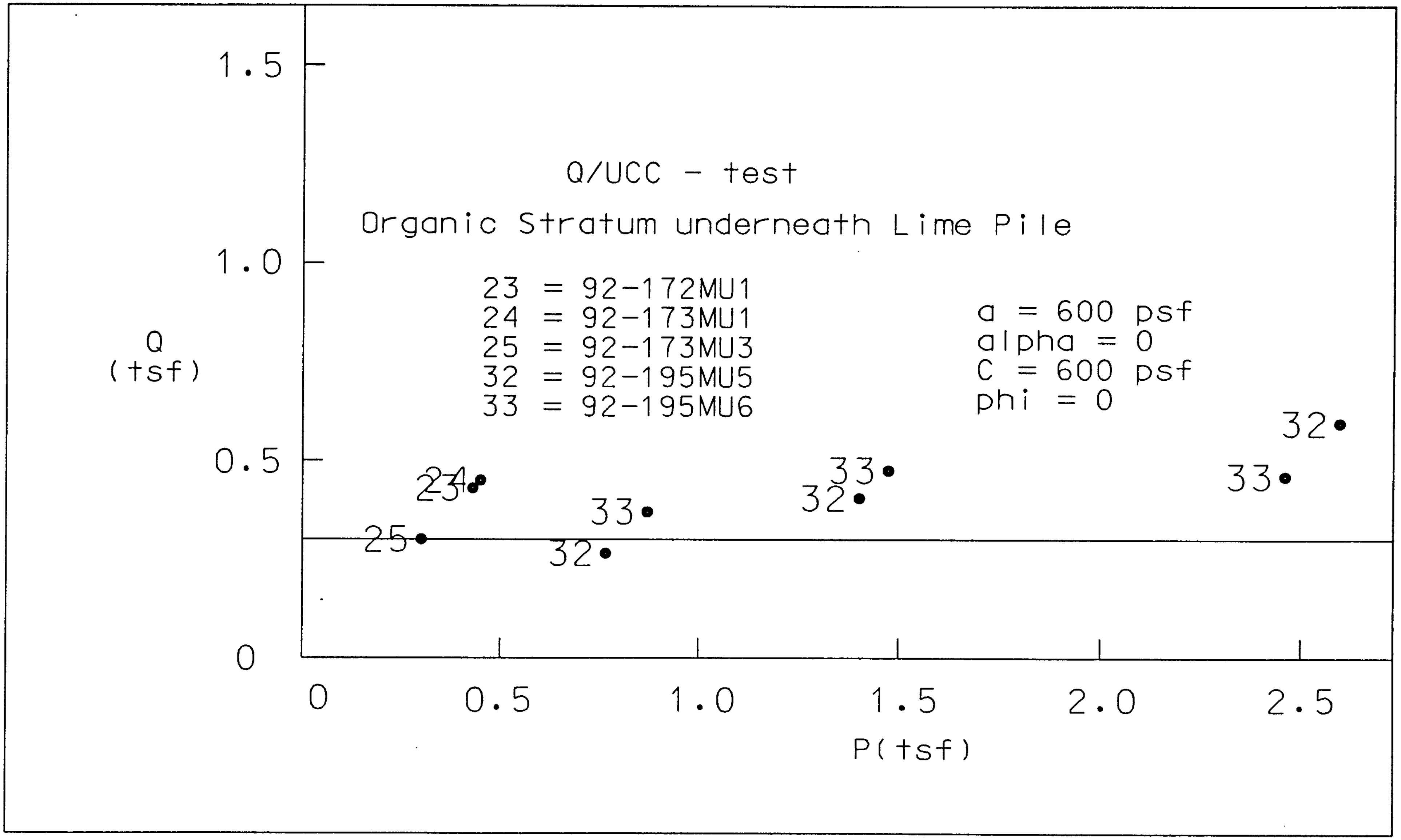
Files were adjusted to transformed permeability with Kh=4*Kv

file	w1h	w2k	w3l10	w4i
I.E.(transformed)	0.2475	0.2427	0.2321	0.237
I.E.(actual)	0.495	0.4854	0.4642	0.474



Q - test
LIME PILE
28 = 92-195MU1
29 = 92-195MU2
30 = 92-195MU3
31 = 92-195MU4
a = 400 psf
alpha = 0 degrees
c = 400 psf
phi = 0 degrees
Q (tsf)
P(tsf)
0
0.5
1.0
1.5
2.0
2.5
28
29
30
31

Plate D-41



Q/UCC - test
Organic Stratum underneath Lime Pile
23 = 92-172MU1
24 = 92-173MU1
25 = 92-173MU3
32 = 92-195MU5
33 = 92-195MU6
a = 600 psf
alpha = 0
C = 600 psf
phi = 0
Q (tsf)
1.5
1.0
0.5
0
0.5
1.0
1.5
2.0
2.5
P(tsf)
24
23
25
33
32
33
32
32
33

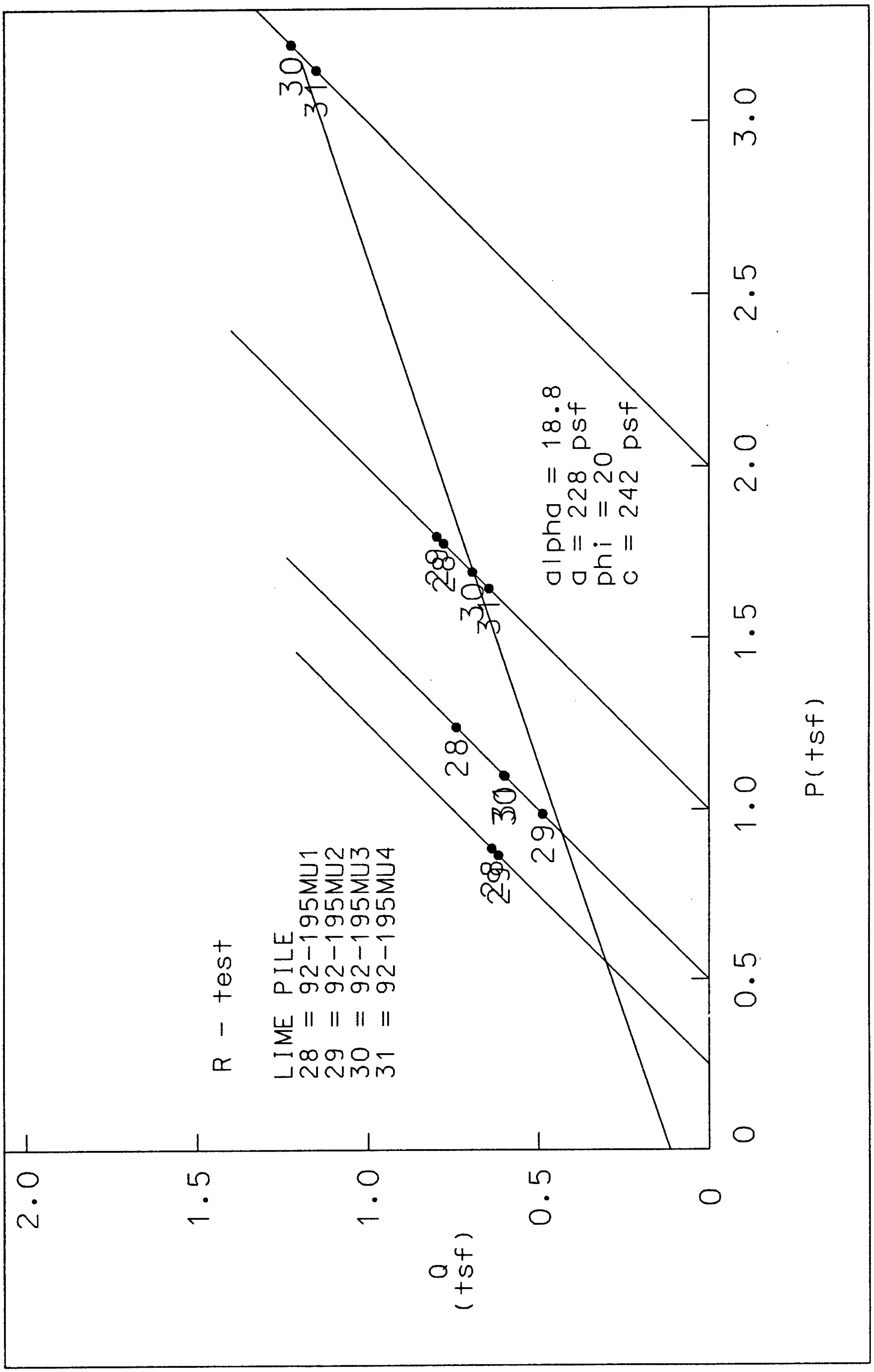
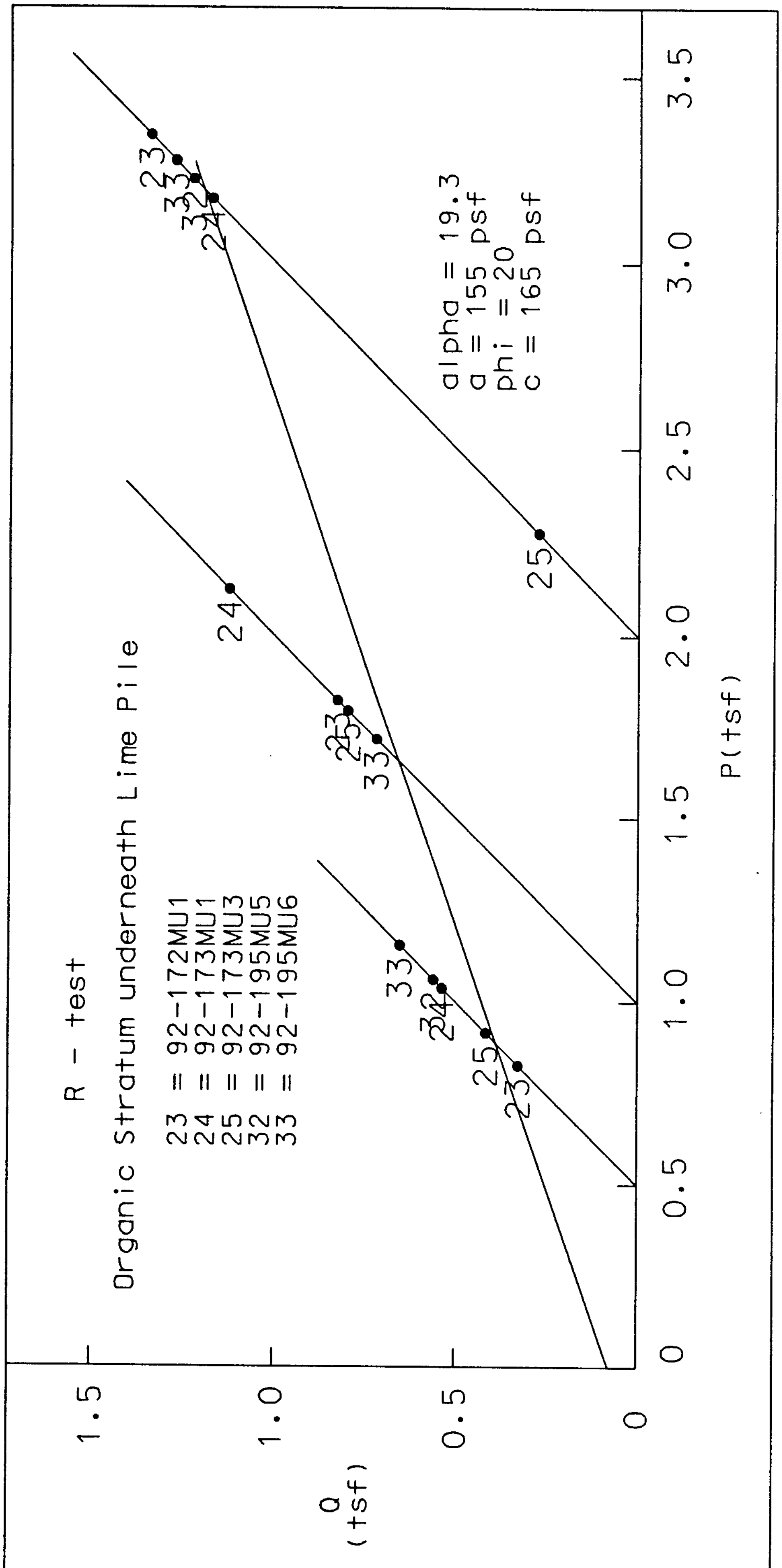

R - test
LIME PILE
28 = 92-195MU1
29 = 92-195MU2
30 = 92-195MU3
31 = 92-195MU4
alpha = 18.8
a = 228 psf
phi = 20
c = 242 psf
P(tsf)
Q (tsf)
0
0.5
1.0
1.5
2.0
2.5
3.0
28
29
30
31

Plate D-43



R - test
Organic Stratum underneath Lime Pile
23 = 92-172MU1
24 = 92-173MU1
25 = 92-173MU3
32 = 92-195MU5
33 = 92-195MU6
alpha = 19.3
a = 155 psf
phi = 20
c = 165 psf
Q (tsf)
P(tsf)
0
0.5
1.0
1.5
2.0
2.5
3.0
3.5

Plate D-44

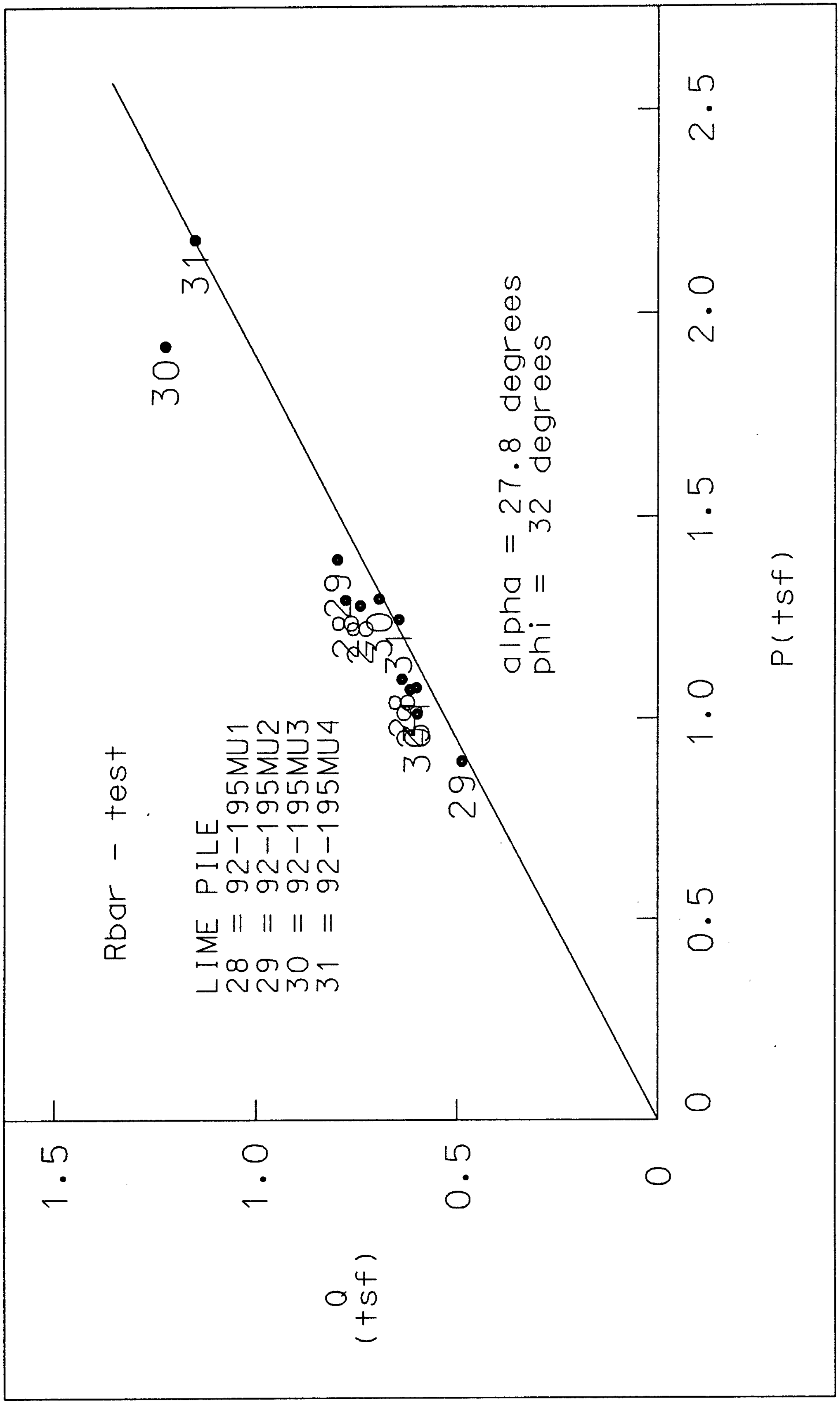
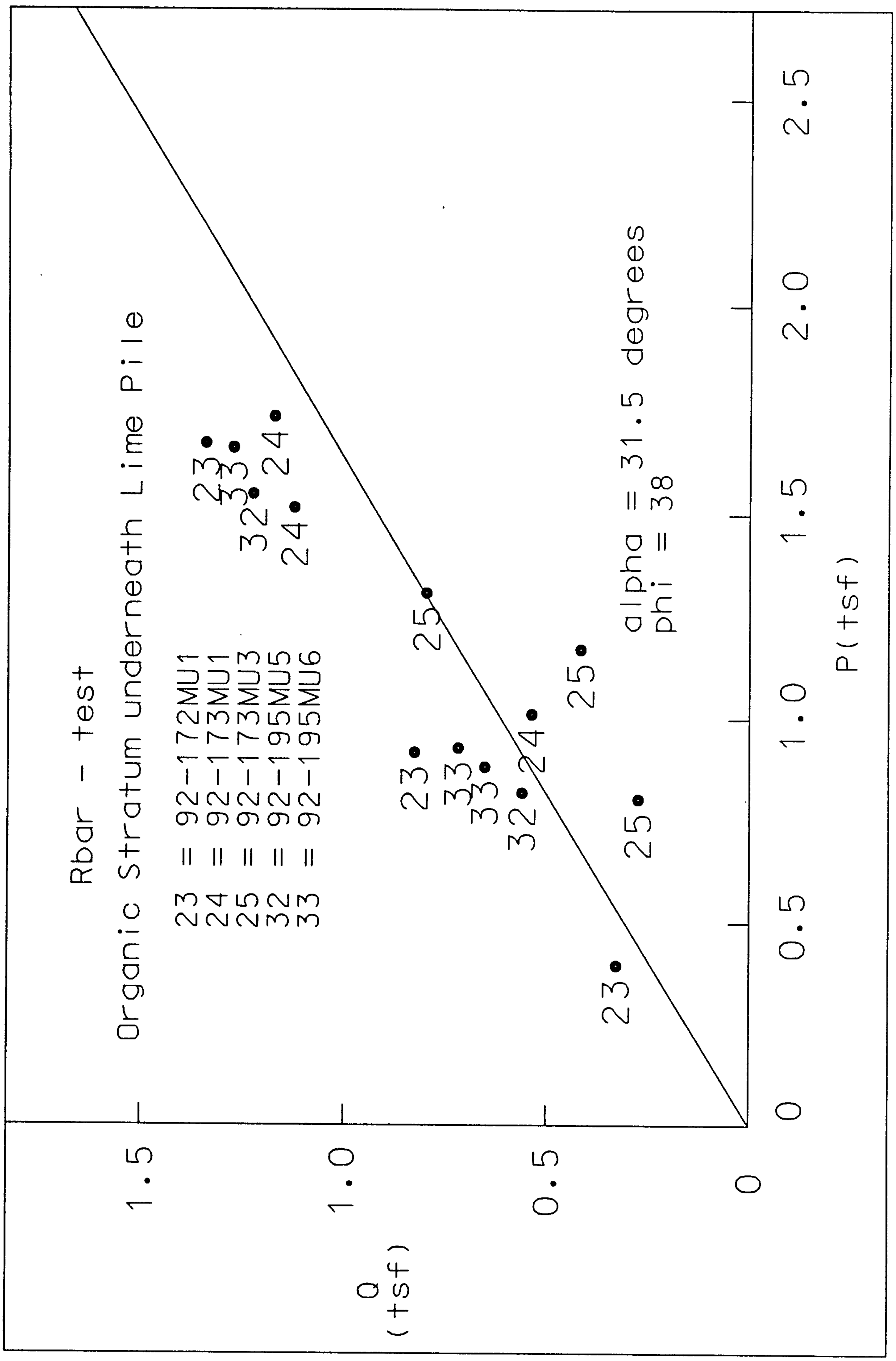
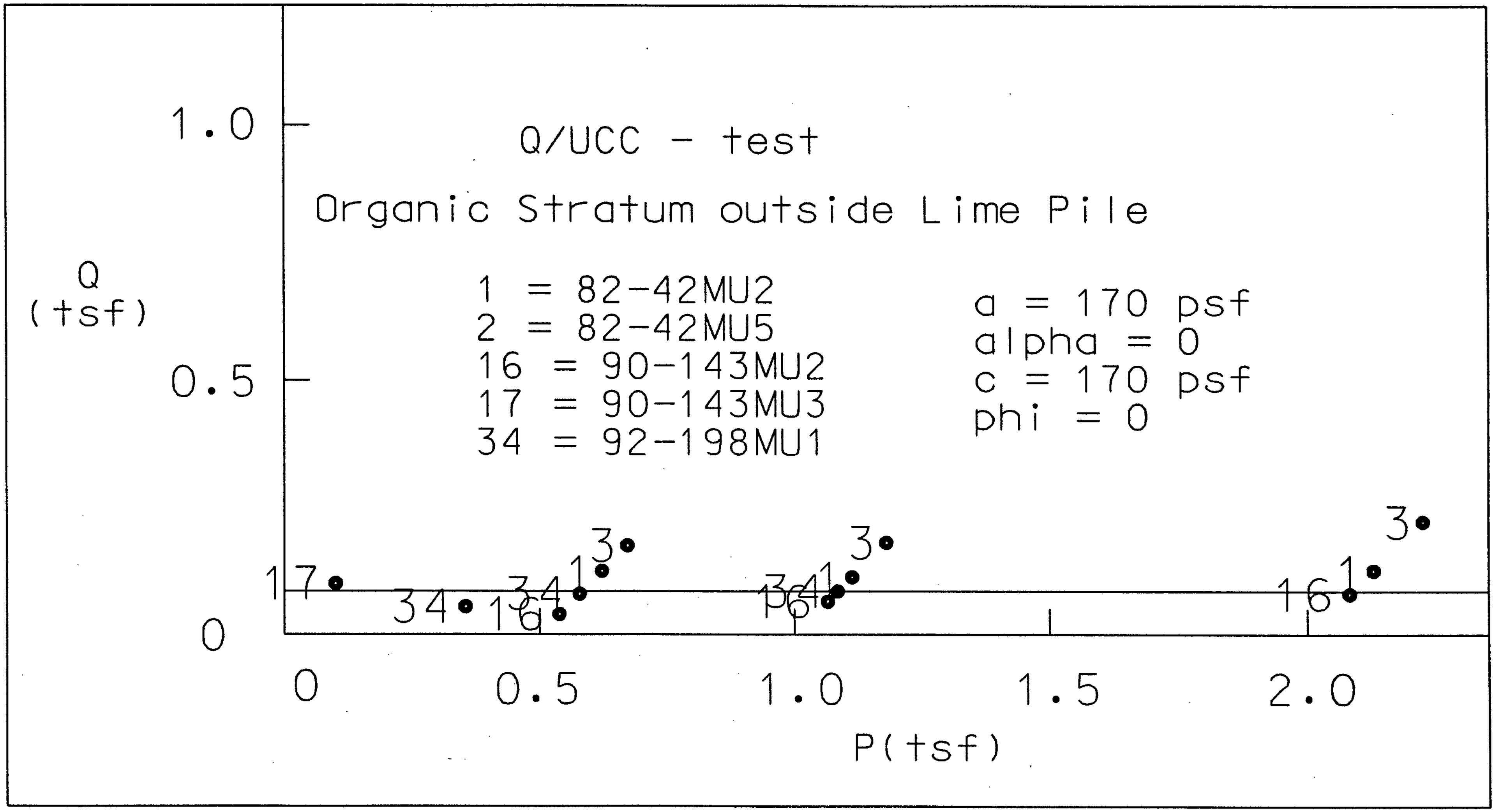
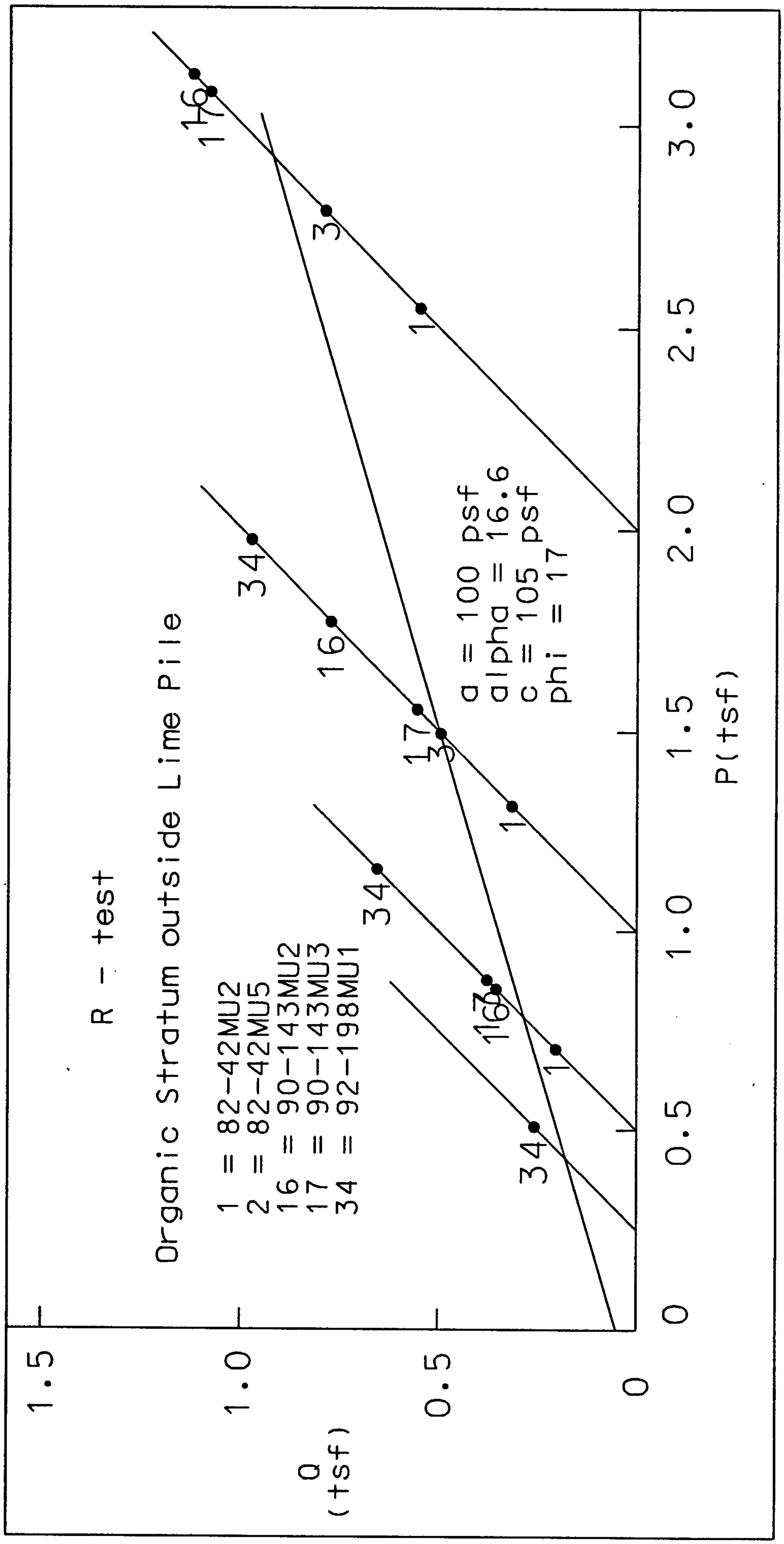

Rbar - test
LIME PILE
28 = 92-195MU1
29 = 92-195MU2
30 = 92-195MU3
31 = 92-195MU4
alpha = 27.8 degrees
phi = 32 degrees
Q
(tsf)
P(tsf)
0
0.5
1.0
1.5
2.0
2.5

Plate D-45


Rbar - test
Organic Stratum underneath Lime Pile
23 = 92-172MU1
24 = 92-173MU1
25 = 92-173MU3
32 = 92-195MU5
33 = 92-195MU6
alpha = 31.5 degrees
phi = 38
Q
(tsf)
P(tsf)
0
0.5
1.0
1.5
2.0
2.5


Q/UCC - test
Organic Stratum outside Lime Pile
1 = 82-42MU2
2 = 82-42MU5
16 = 90-143MU2
17 = 90-143MU3
34 = 92-198MU1
a = 170 psf
alpha = 0
c = 170 psf
phi = 0
Q (tsf)
1.0
0.5
0
0
0.5
1.0
1.5
2.0
P(tsf)


R - test
Organic Stratum outside Lime Pile
1 = 82-42MU2
2 = 82-42MU5
16 = 90-143MU2
17 = 90-143MU3
34 = 92-198MU1
a = 100 psf
alpha = 16.6
c = 105 psf
phi = 17
Q (tsf)
P (tsf)
0
0.5
1.0
1.5
2.0
2.5
3.0

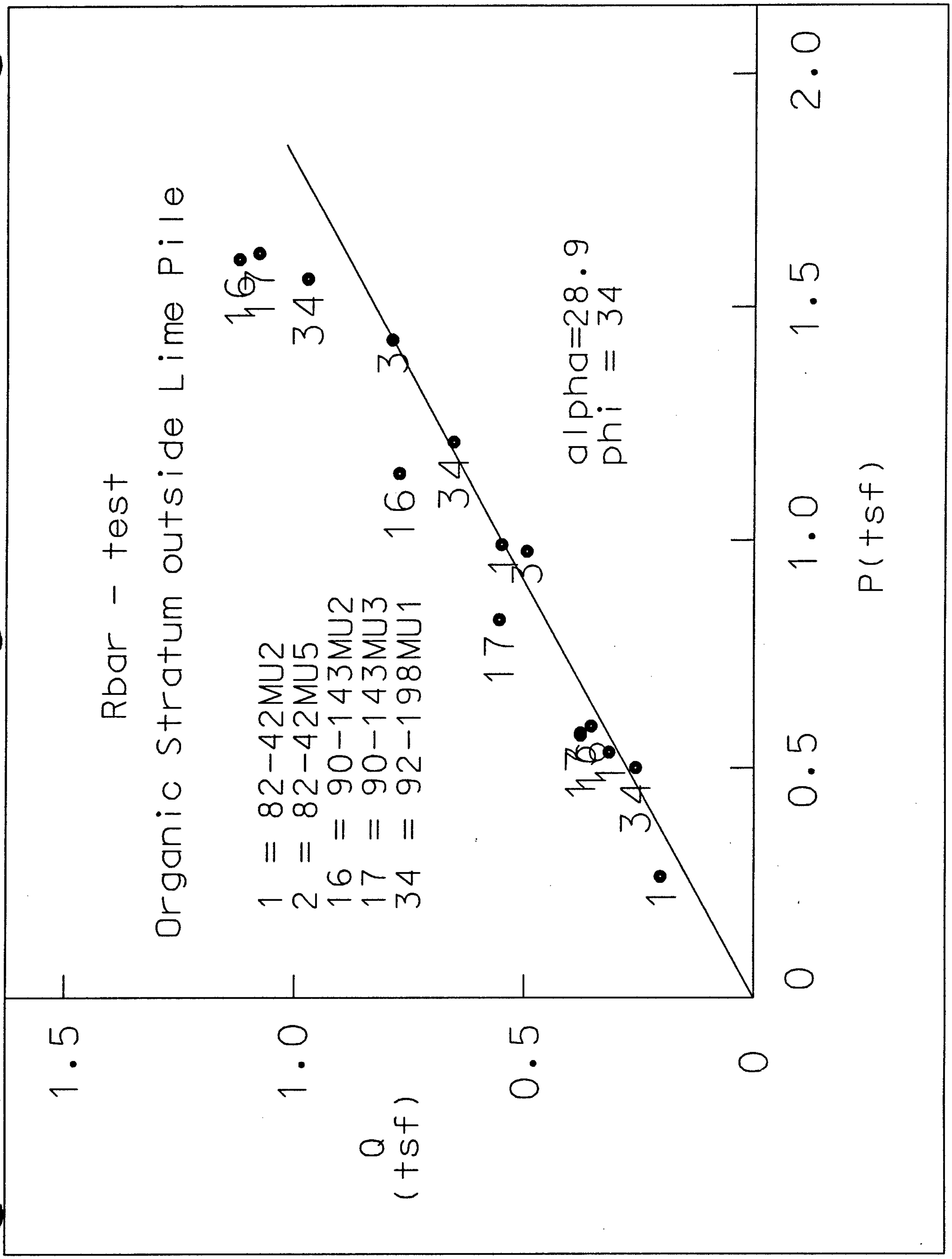

Rbar - test
Organic Stratum outside Lime Pile
1 = 82-42MU2
2 = 82-42MU5
16 = 90-143MU2
17 = 90-143MU3
34 = 92-198MU1
alpha=28.9
phi = 34
Q (tsf)
P(tsf)
0
0.5
1.0
1.5
2.0

Plate D-49

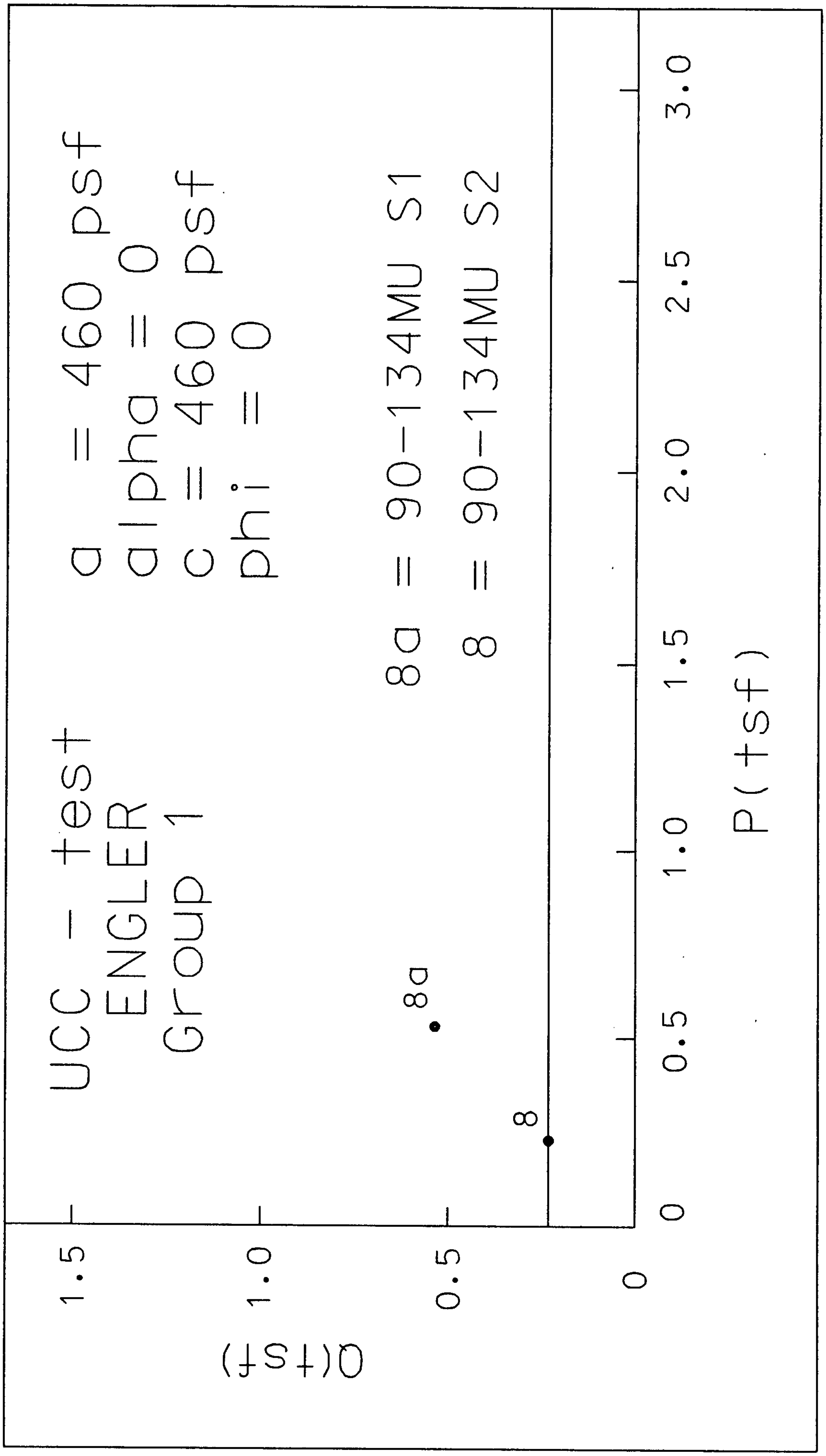
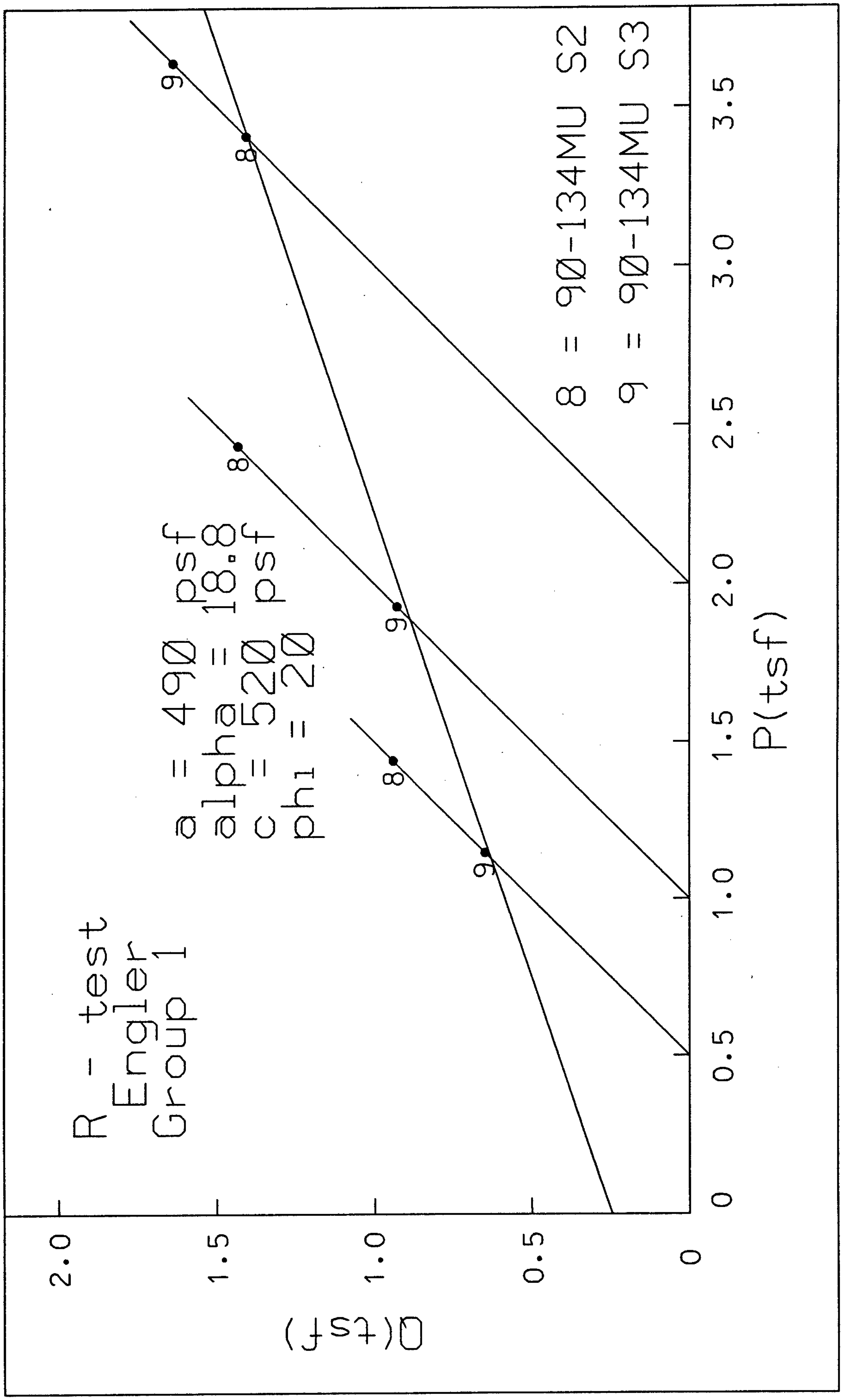
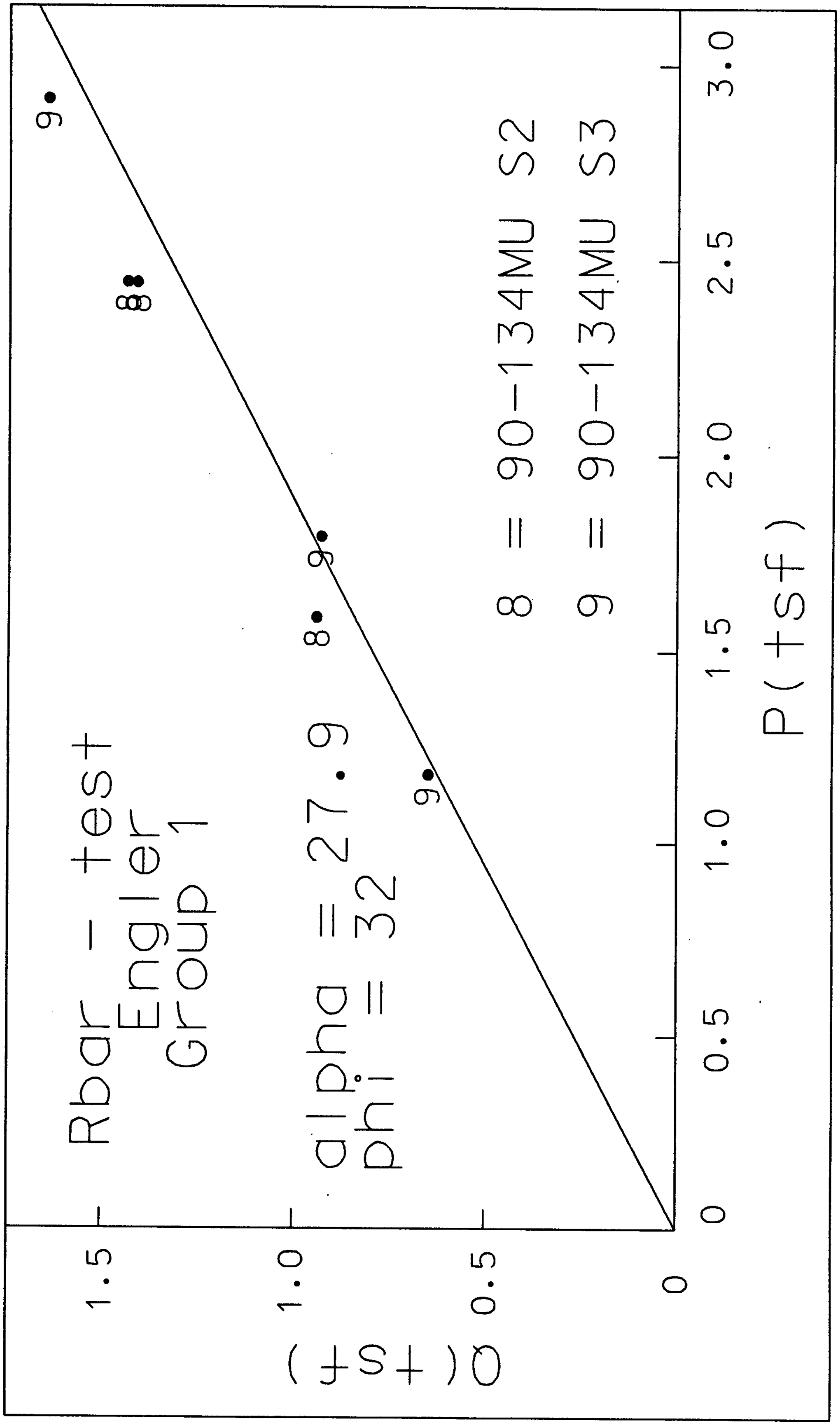

UCC - test
ENGLER
Group 1
a = 460 psf
alpha = 0
c = 460 psf
phi = 0
8a = 90-134MU S1
8 = 90-134MU S2
8a
8
Q(tsf)
P(tsf)
0
0.5
1.0
1.5
2.0
2.5
3.0

PLATE D-50



R - test
Engler
Group 1
a = 490 psf
alpha = 18.8
c = 520 psf
phi = 20
8 = 90-134MU S2
9 = 90-134MU S3
P(tsf)
Q(tsf)
0
0.5
1.0
1.5
2.0
2.5
3.0
3.5

PLATE D-51



Rbar - test
Engler
Group 1
alpha = 27.9
phi = 32
8 = 90-134MU S2
9 = 90-134MU S3
Q(+sf)
P(+sf)
0
0.5
1.0
1.5
2.0
2.5
3.0

PLATE D-52

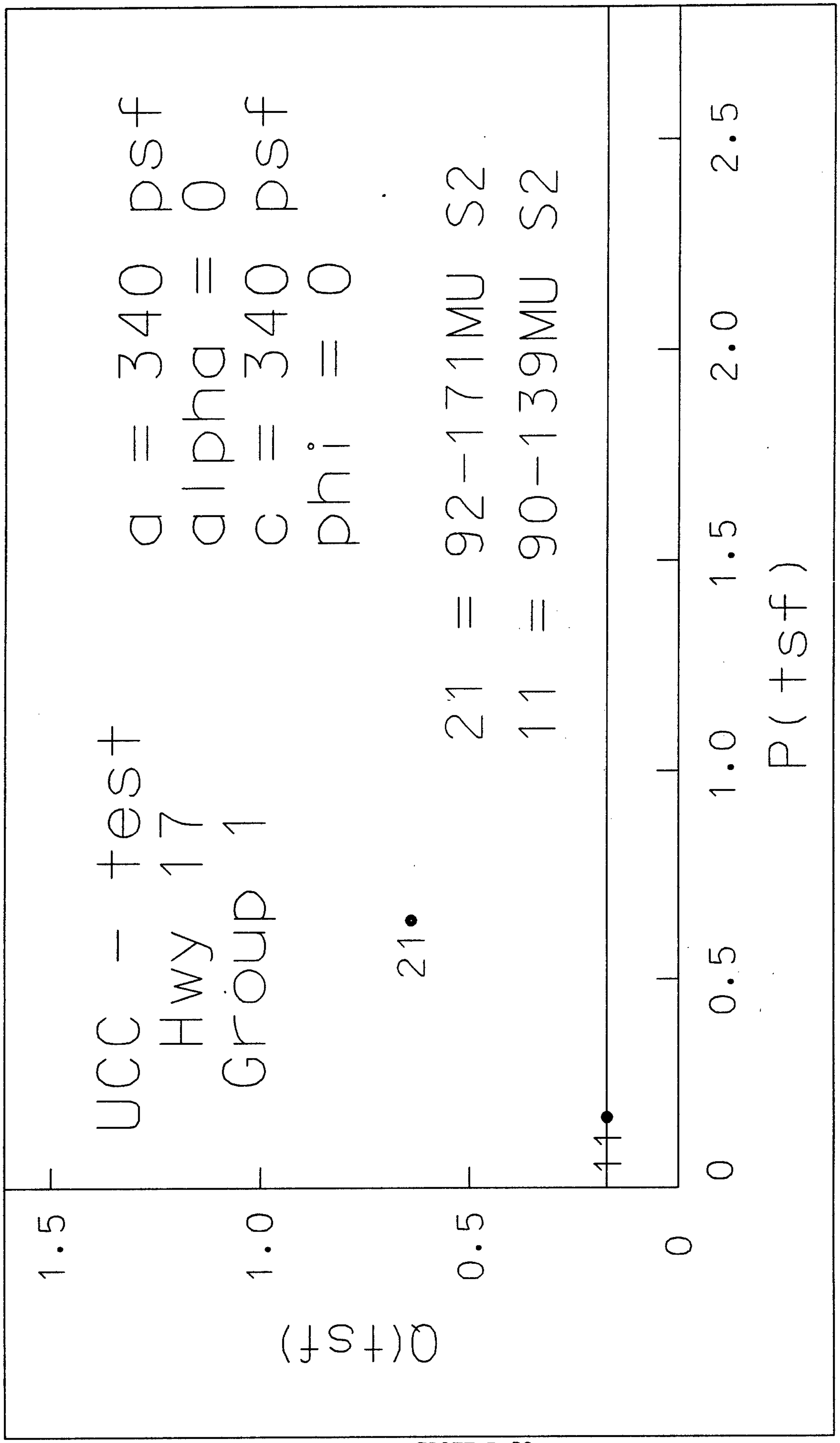

UCC - test
Hwy 17
Group 1
a = 340 psf
alpha = 0
c = 340 psf
phi = 0
21 = 92-171MU S2
11 = 90-139MU S2
21
11
P(tsf)
Q(tsf)
0
0.5
1.0
1.5
2.0
2.5
0
0.5
1.0
1.5

PLATE D-53

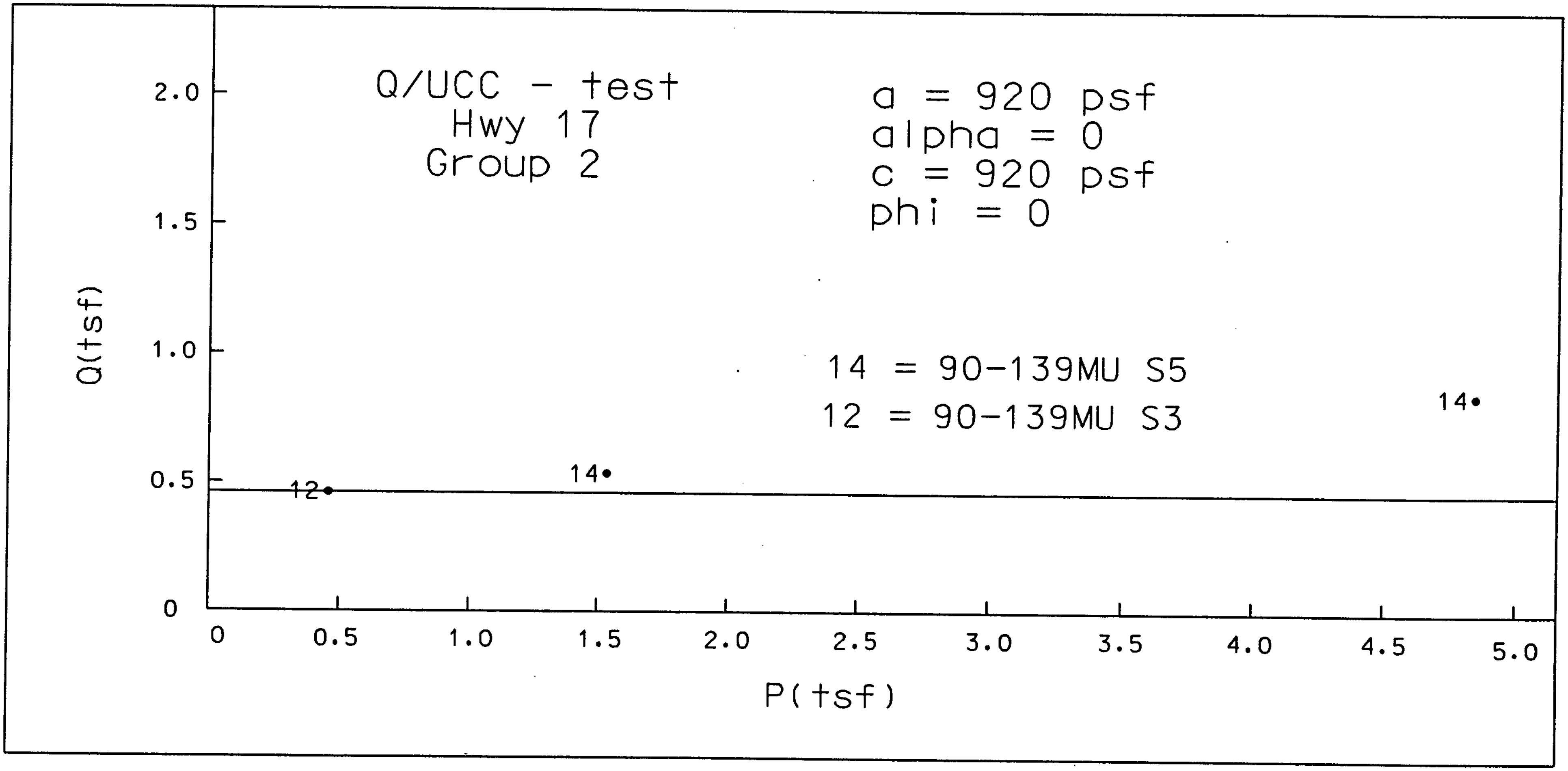
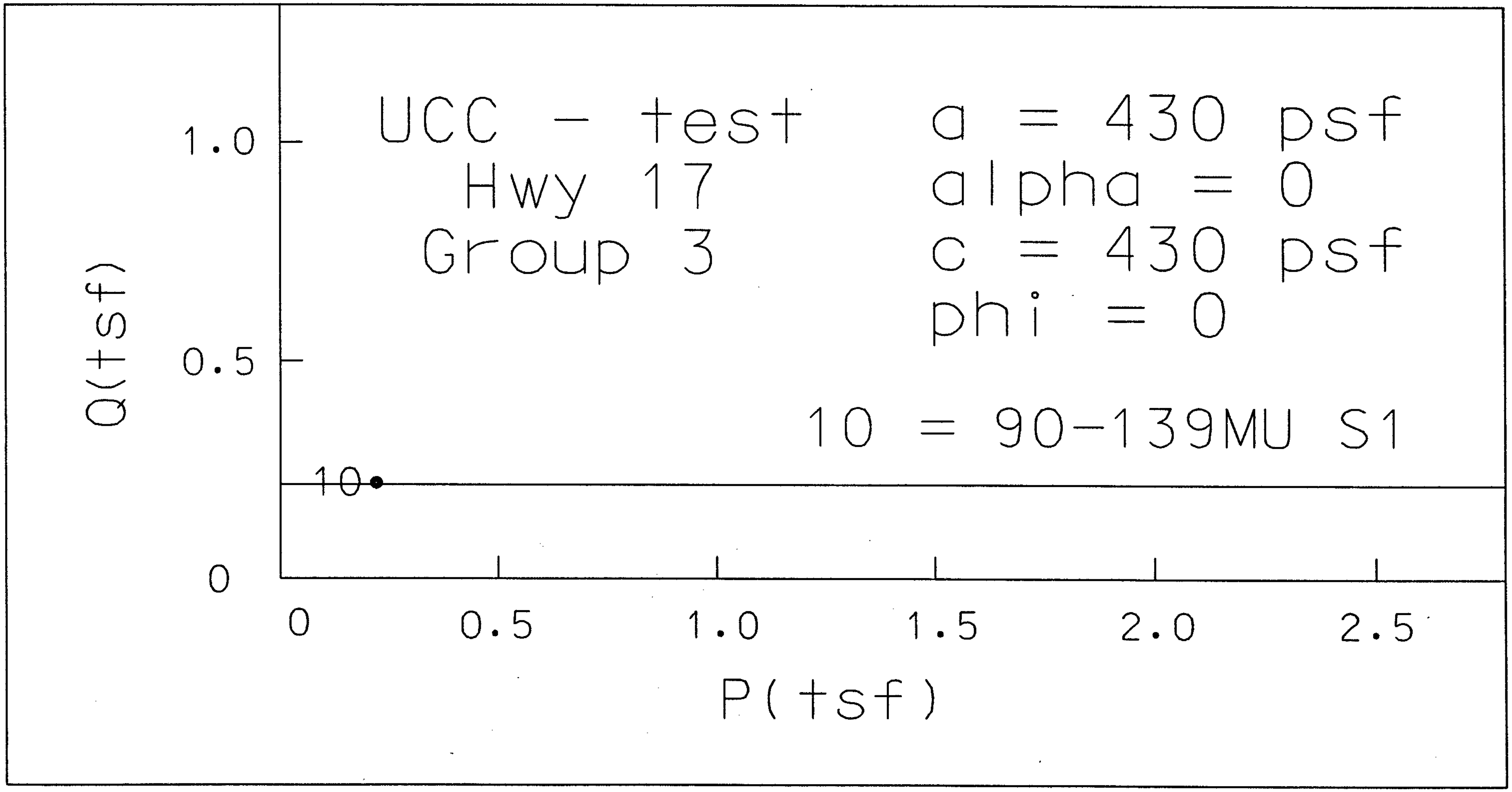
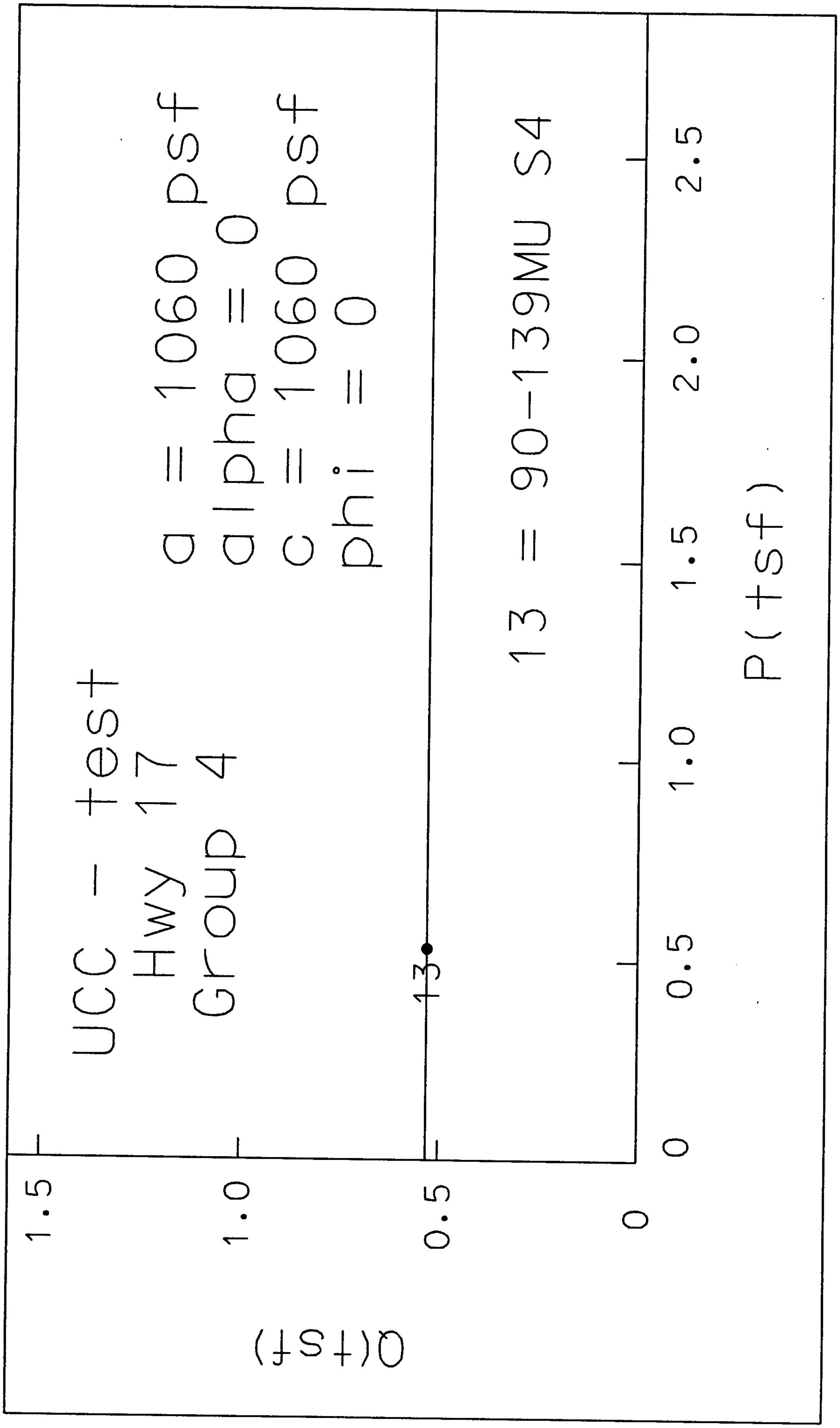

Q/UCC - test
Hwy 17
Group 2
a = 920 psf
alpha = 0
c = 920 psf
phi = 0
14 = 90-139MU S5
12 = 90-139MU S3
Q(tsf)
P(tsf)
0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
12
14
14

PLATE D-54



UCC - test
Hwy 17
Group 3
a = 430 psf
alpha = 0
c = 430 psf
phi = 0
10 = 90-139MU S1
10
Q(tsf)
1.0
0.5
0
0
0.5
1.0
1.5
2.0
2.5
P(tsf)

PLATE D-55



UCC - test
Hwy 17
Group 4
a = 1060 psf
alpha = 0
c = 1060 psf
phi = 0
13 = 90-139MU S4
13
0
0.5
1.0
1.5
2.0
2.5
P(tsf)
Q(tsf)

PLATE D-56

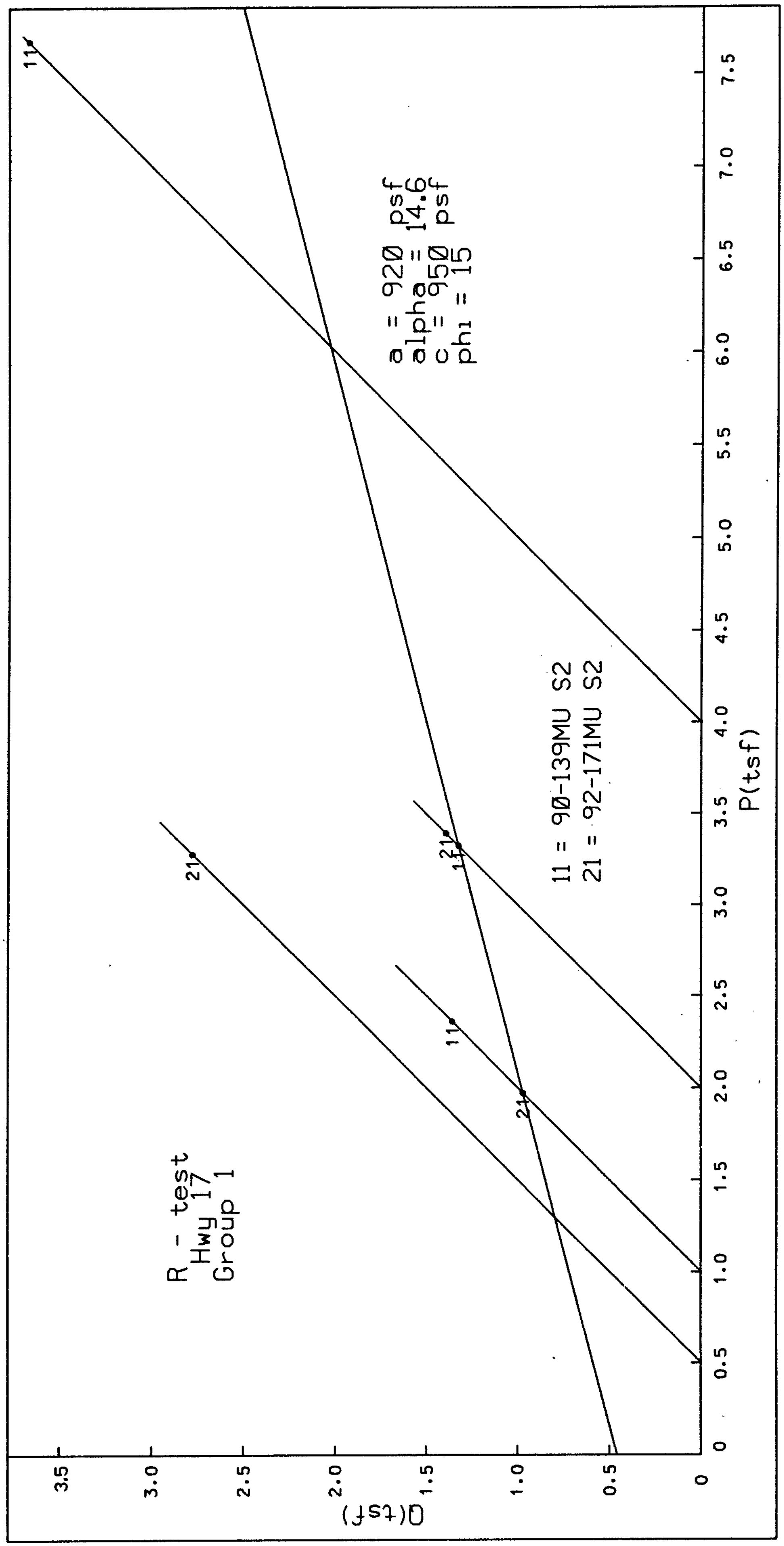
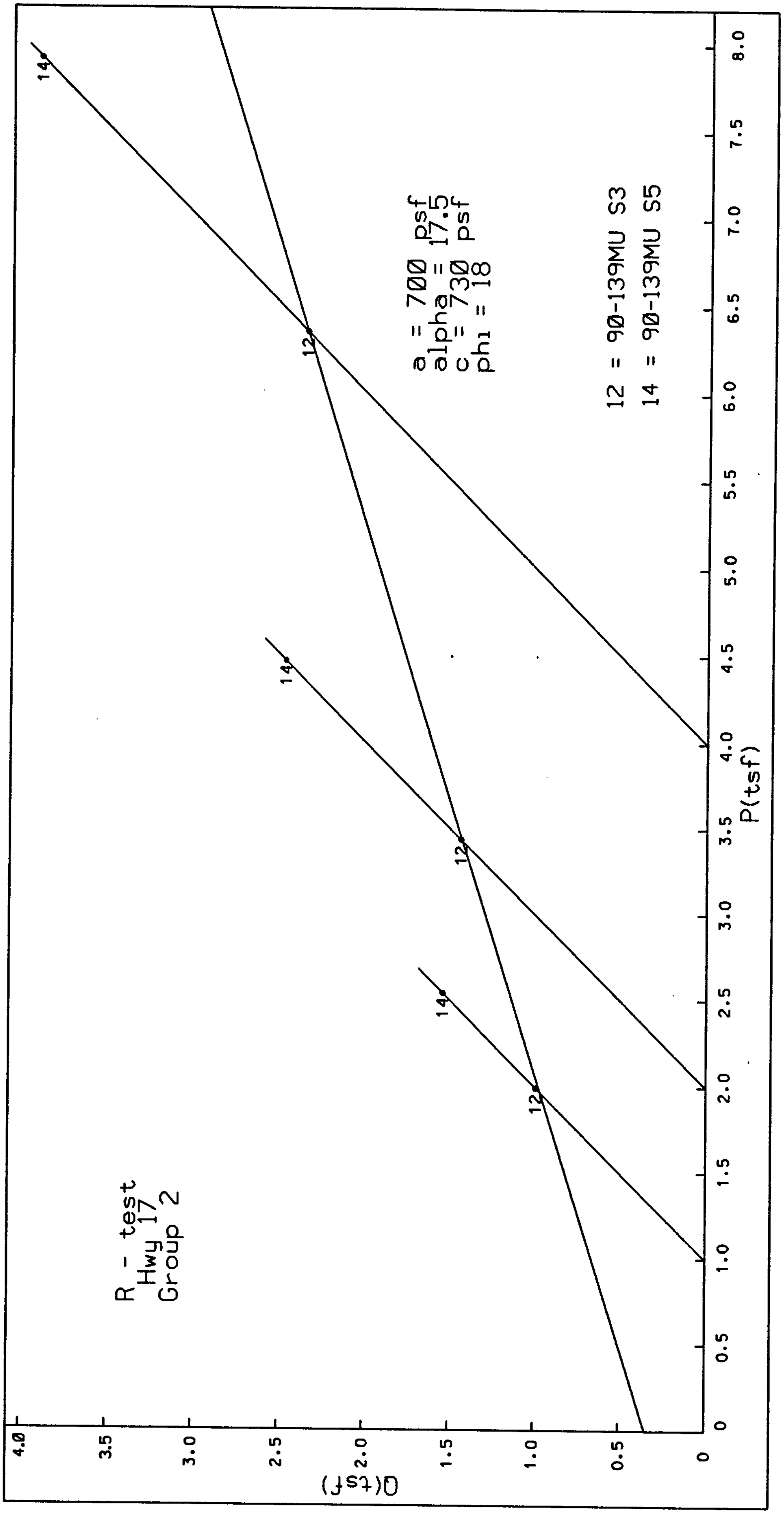

R - test
Hwy 17
Group 1
11 = 90-139MU S2
21 = 92-171MU S2
a = 920 psf
alpha = 14.6
c = 950 psf
phi = 15
P(tsf)
Q(tsf)
0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5

PLATE D-57



R - test
Hwy 17
Group 2
a = 700 psf
alpha = 17.5
c = 730 psf
phi = 18
12 = 90-139MU S3
14 = 90-139MU S5
P(tsf)
Q(tsf)
0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0

PLATE D-58

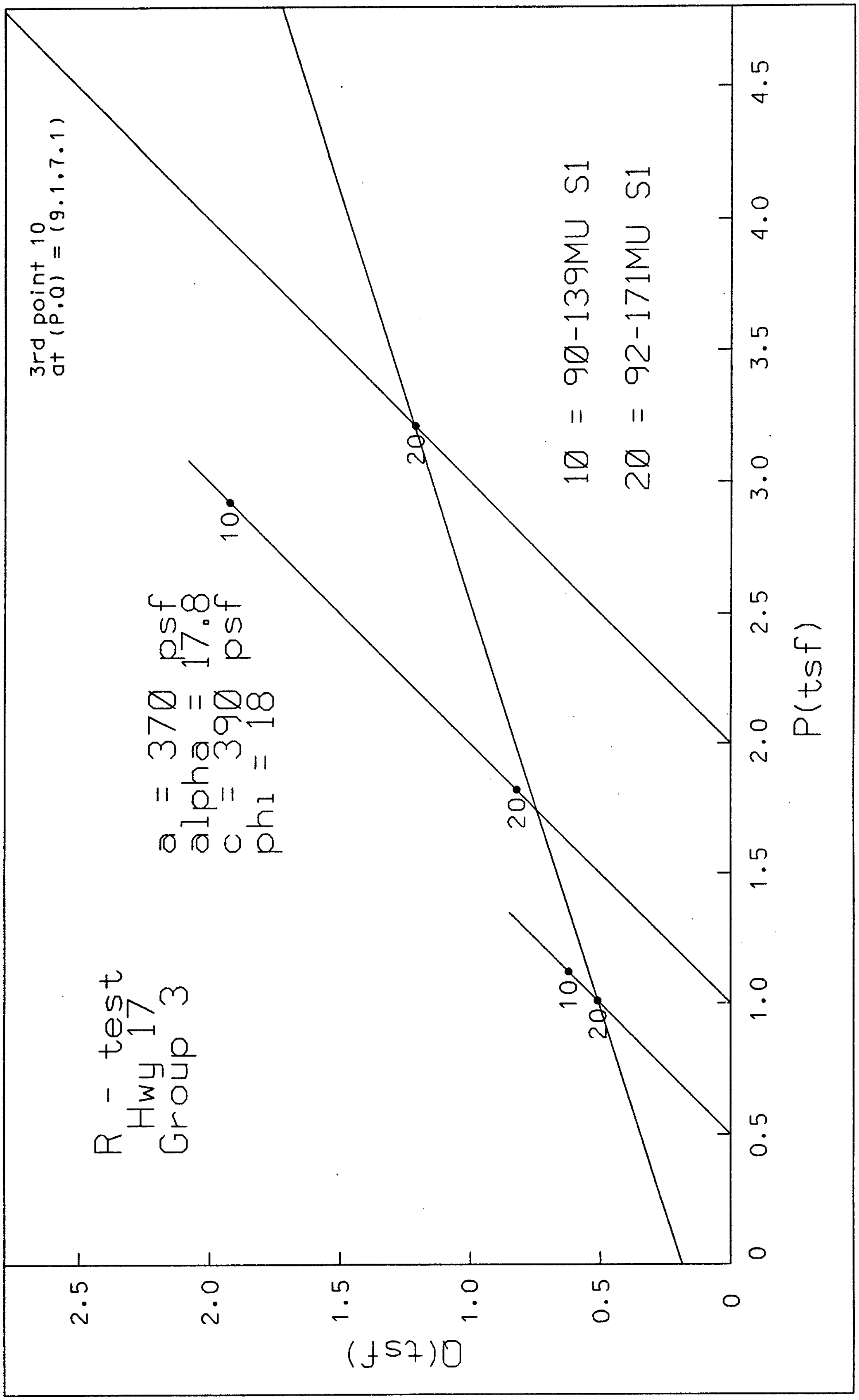

R - test
Hwy 17
Group 3
a = 370 psf
alpha = 17.8
c = 390 psf
phi = 18
3rd point 10
at (P,Q) = (9.1,7.1)
10 = 90-139MU S1
20 = 92-171MU S1
10
20
10
20
20
P(tsf)
Q(tsf)
0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
0
0.5
1.0
1.5
2.0
2.5

PLATE D-59

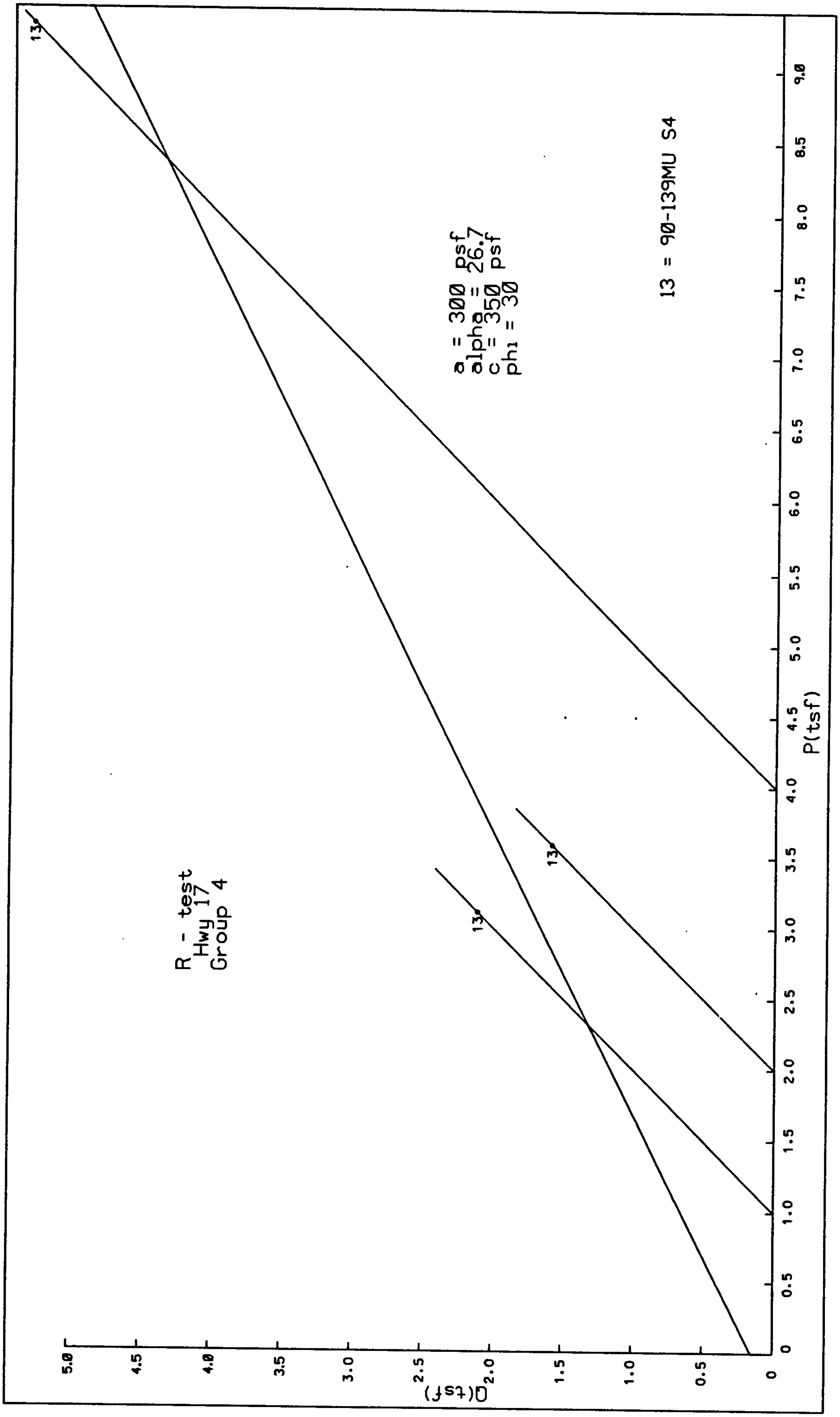
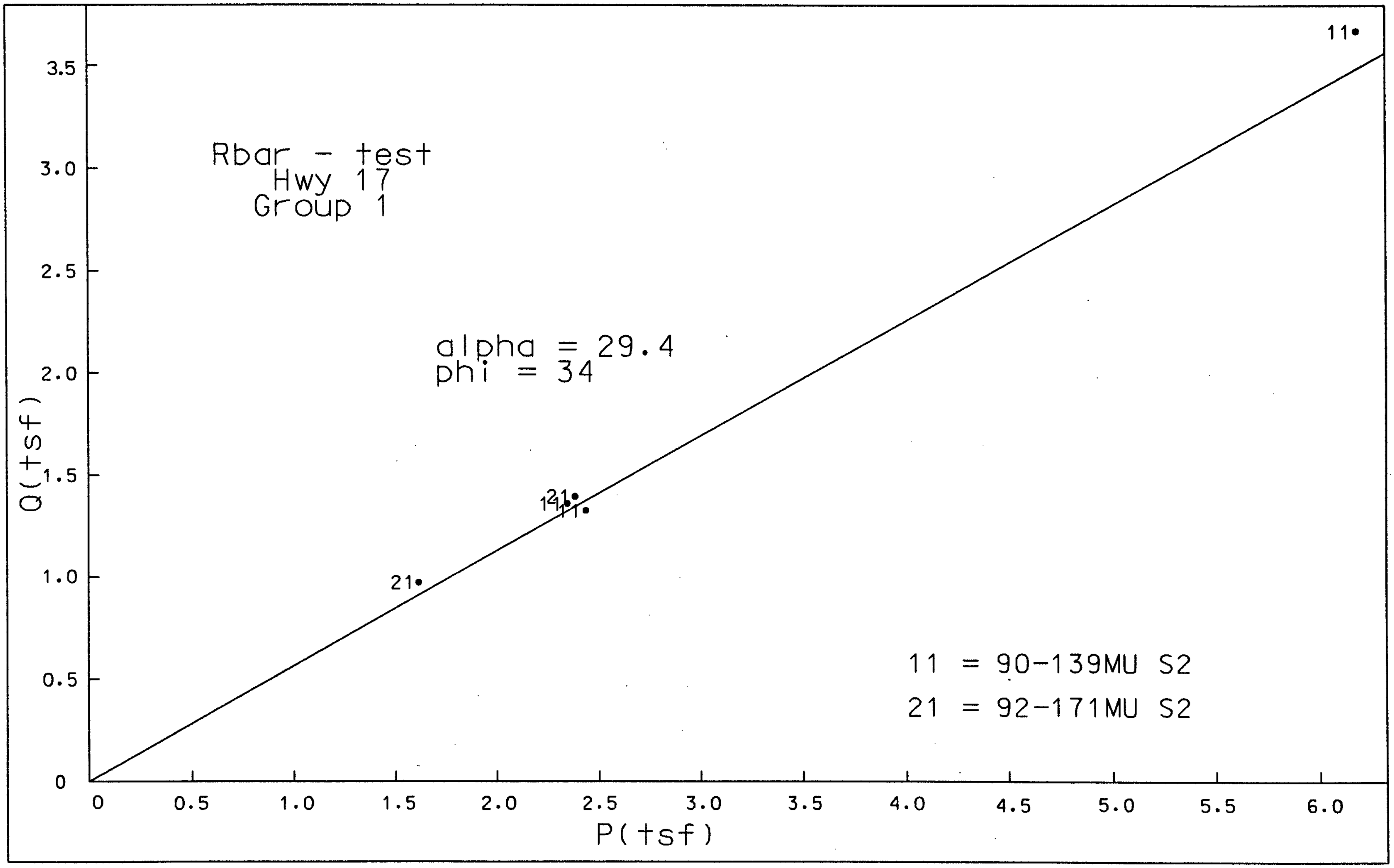
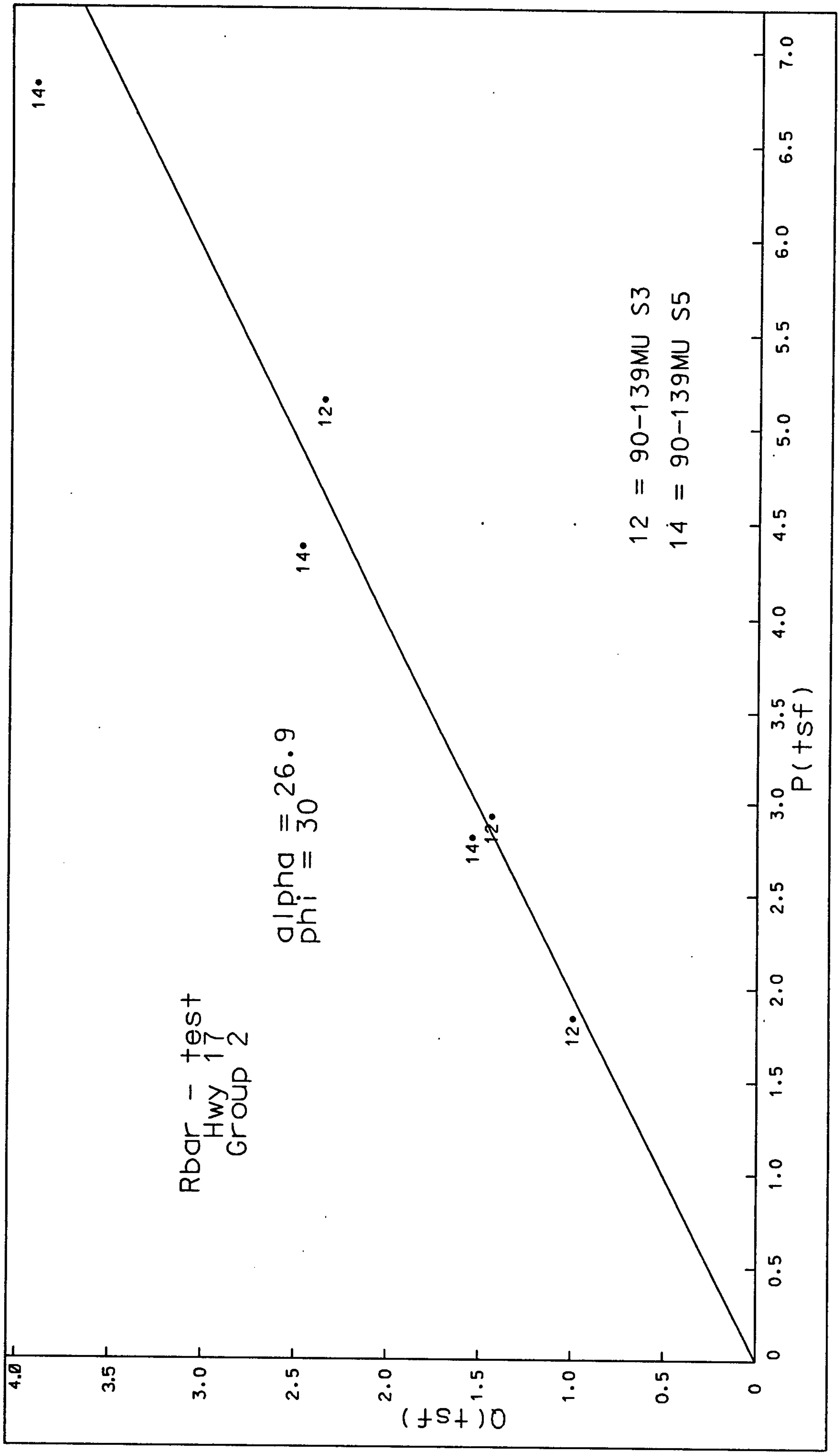

R - test
Hwy 17
Group 4
a = 300 psf
alpha = 26.7
c = 350 psf
phi = 30
13 = 90-139MU S4
P(tsf)
Q(tsf)
0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0
8.5
9.0
13
13
13
13

PLATE D-60



Rbar - test
Hwy 17
Group 1
alpha = 29.4
phi = 34
11 = 90-139MU S2
21 = 92-171MU S2
Q(tsf)
P(tsf)
0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
11
21

PLATE D-61



Rbar - test
Hwy 17
Group 2
alpha = 26.9
phi = 30
12 = 90-139MU S3
14 = 90-139MU S5
P(tsf)
Q(tsf)
0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0

PLATE D-62

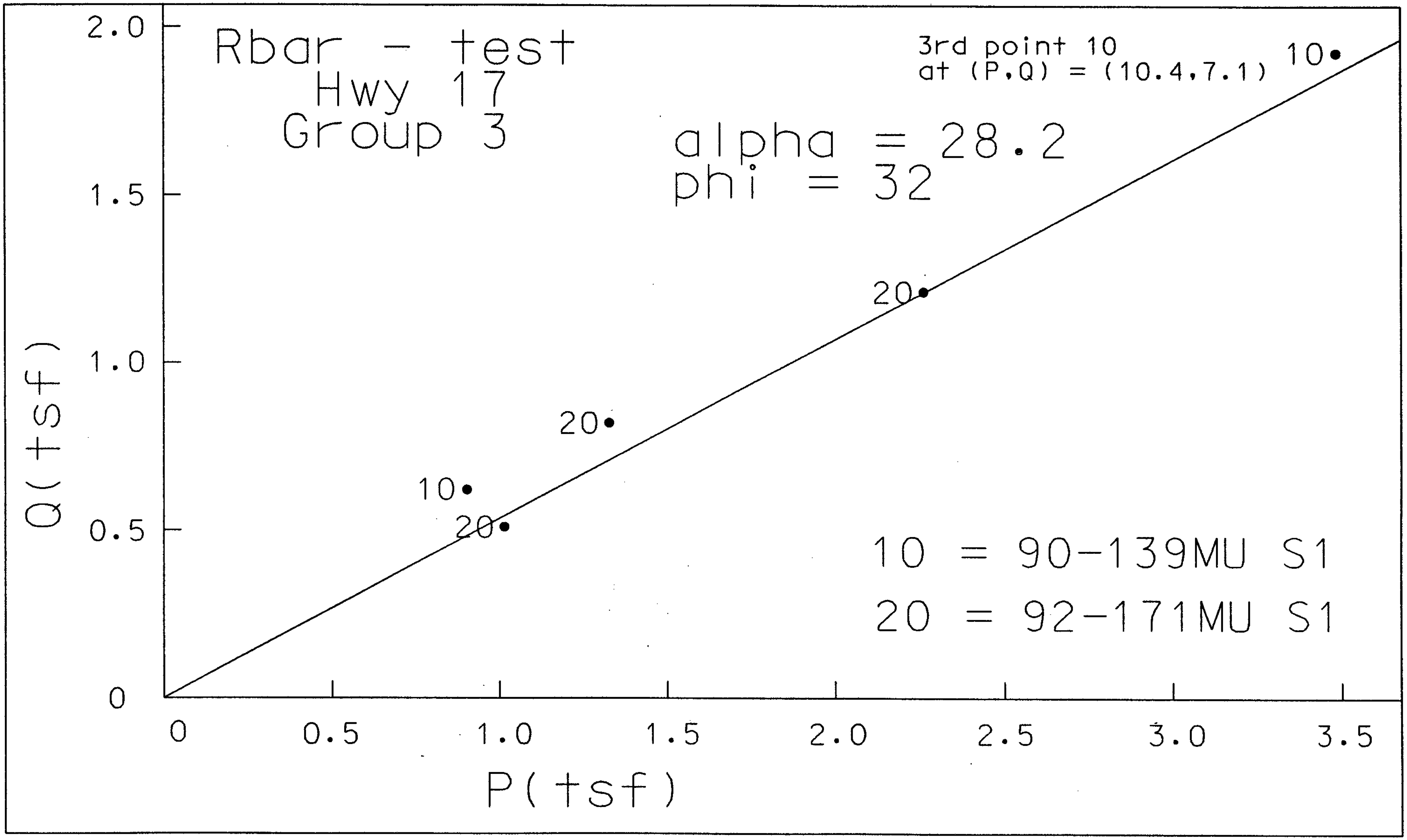
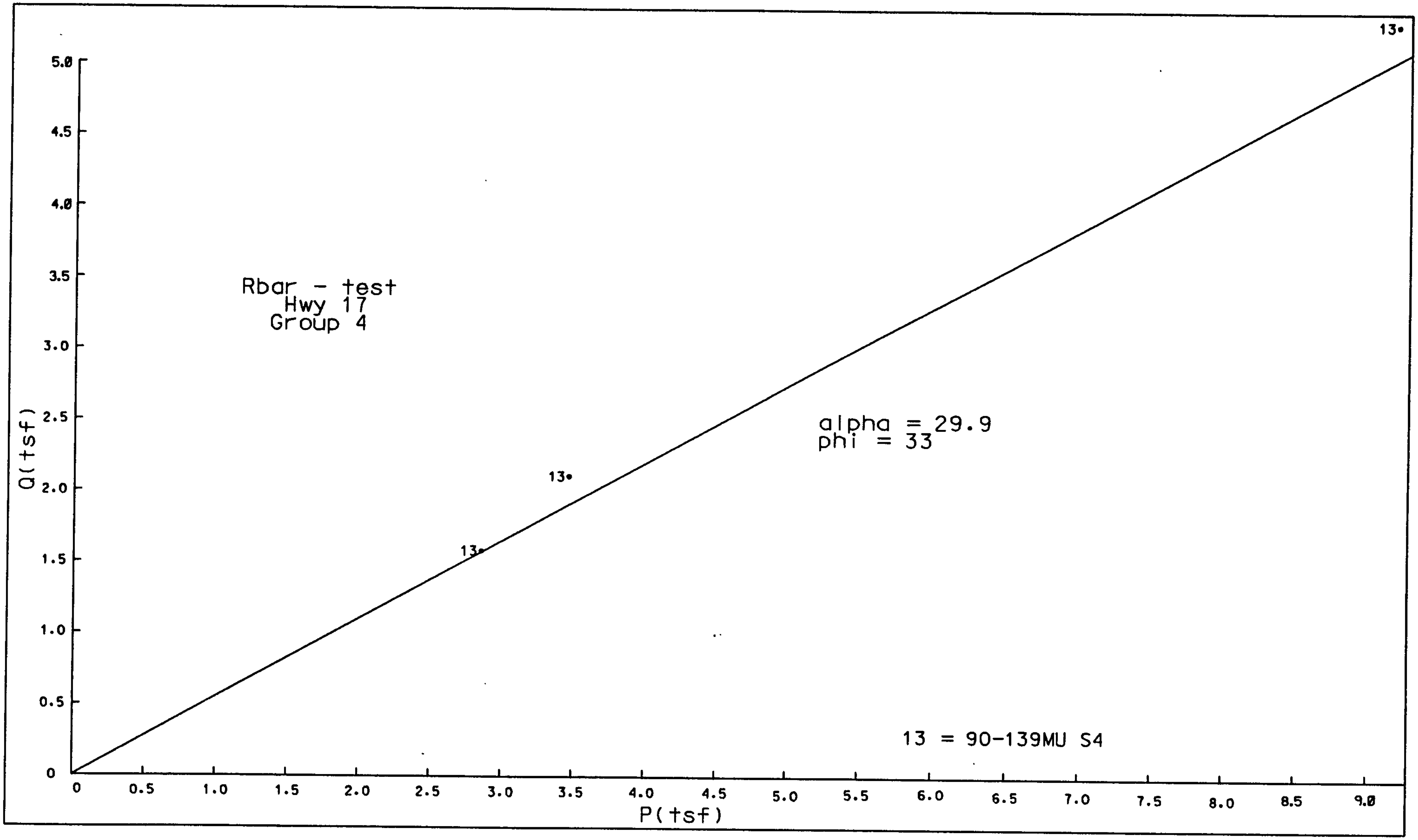
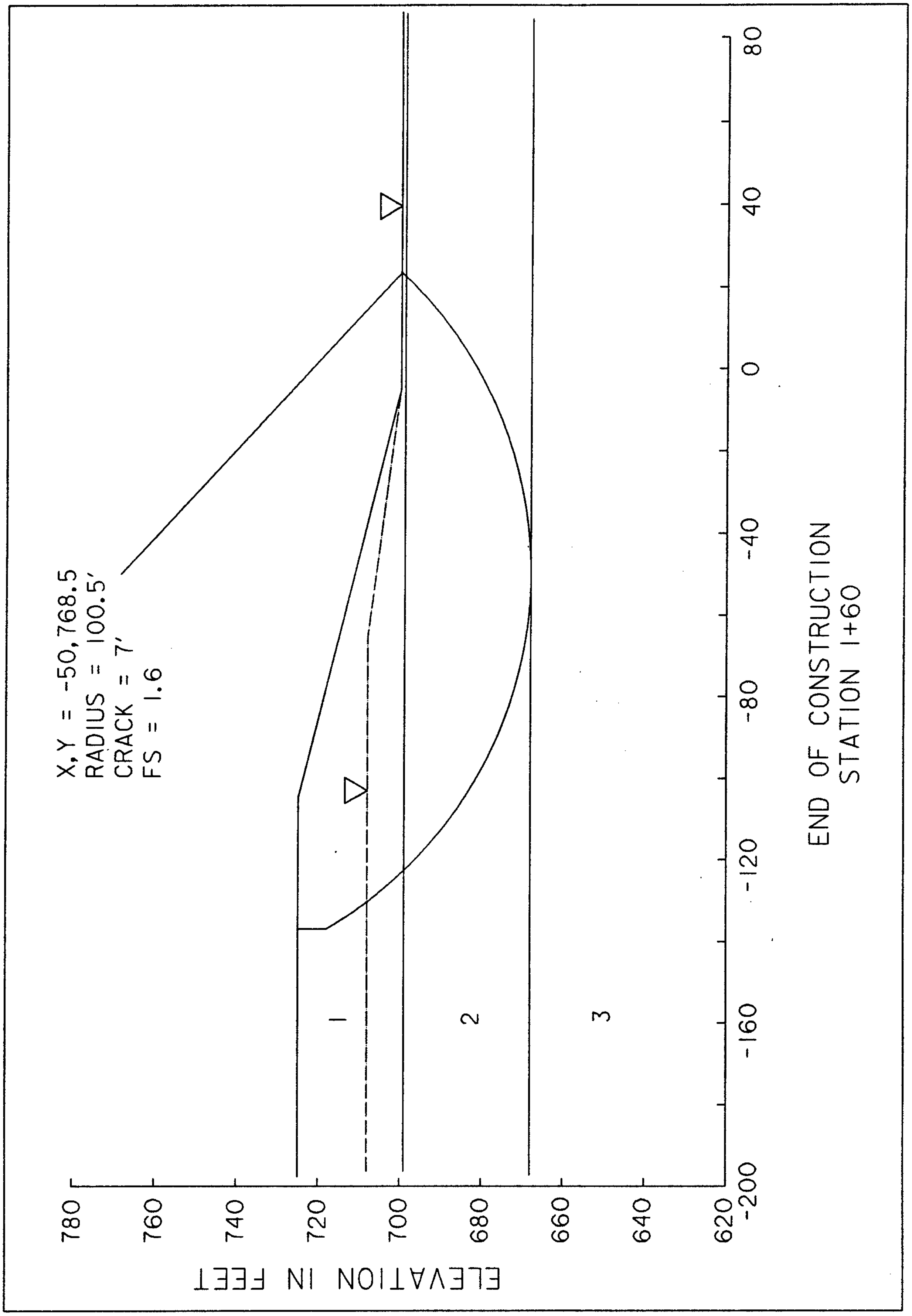

Rbar - test
Hwy 17
Group 3
3rd point 10
at (P,Q) = (10.4,7.1)
alpha = 28.2
phi = 32
10 = 90-139MU S1
20 = 92-171MU S1
Q(tsf)
P(tsf)
0
0.5
1.0
1.5
2.0
2.5
3.0
3.5

PLATE D-63



Rbar - test
Hwy 17
Group 4
alpha = 29.9
phi = 33
13 = 90-139MU S4
Q(tsf)
P(tsf)

PLATE D-64



X,Y = -50,768.5
RADIUS = 100.5'
CRACK = 7'
FS = 1.6
END OF CONSTRUCTION
STATION 1+60
ELEVATION IN FEET
1
2
3
780
760
740
720
700
680
660
640
620
-200
-160
-120
-80
-40
0
40
80

PLATE D-65

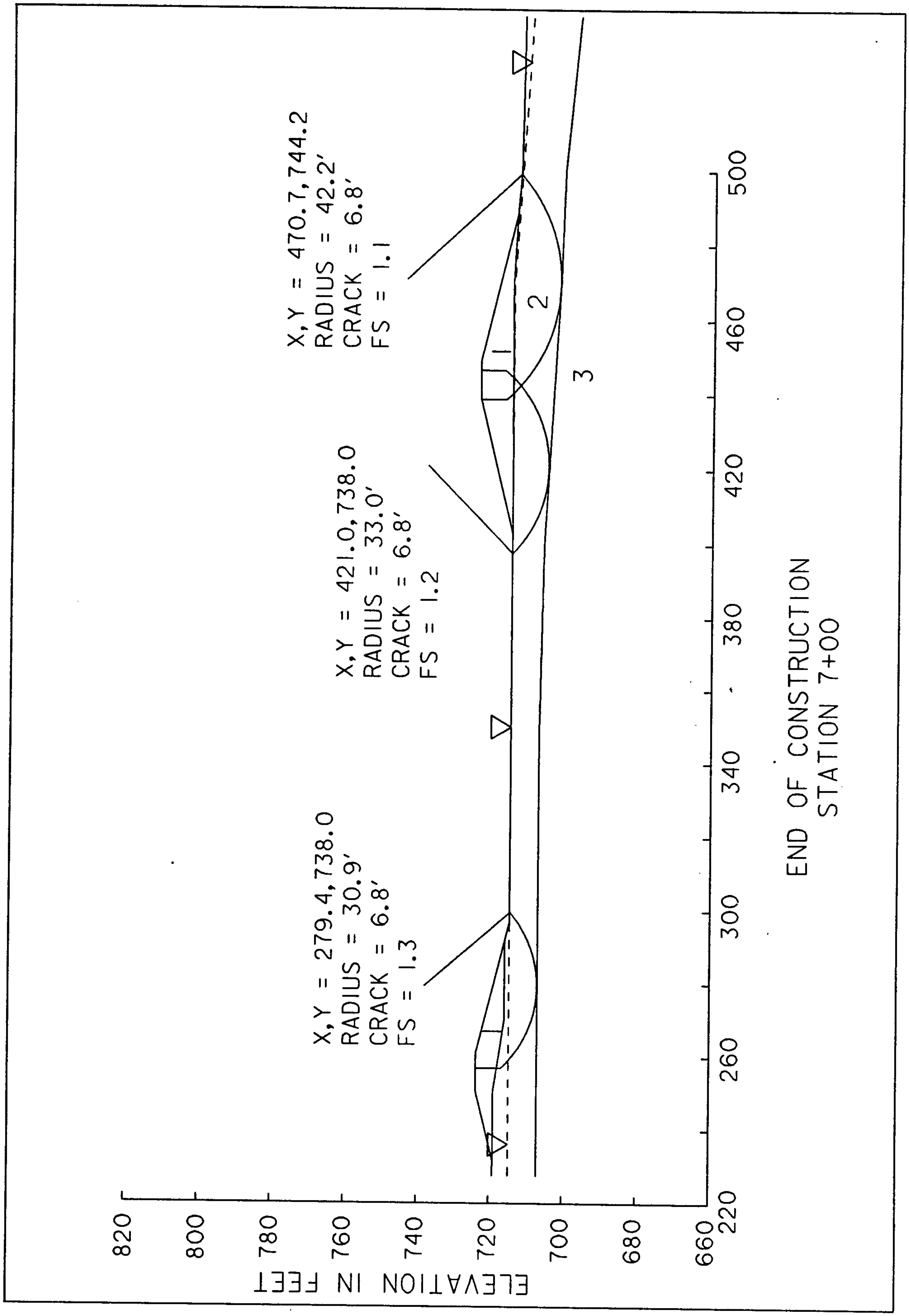
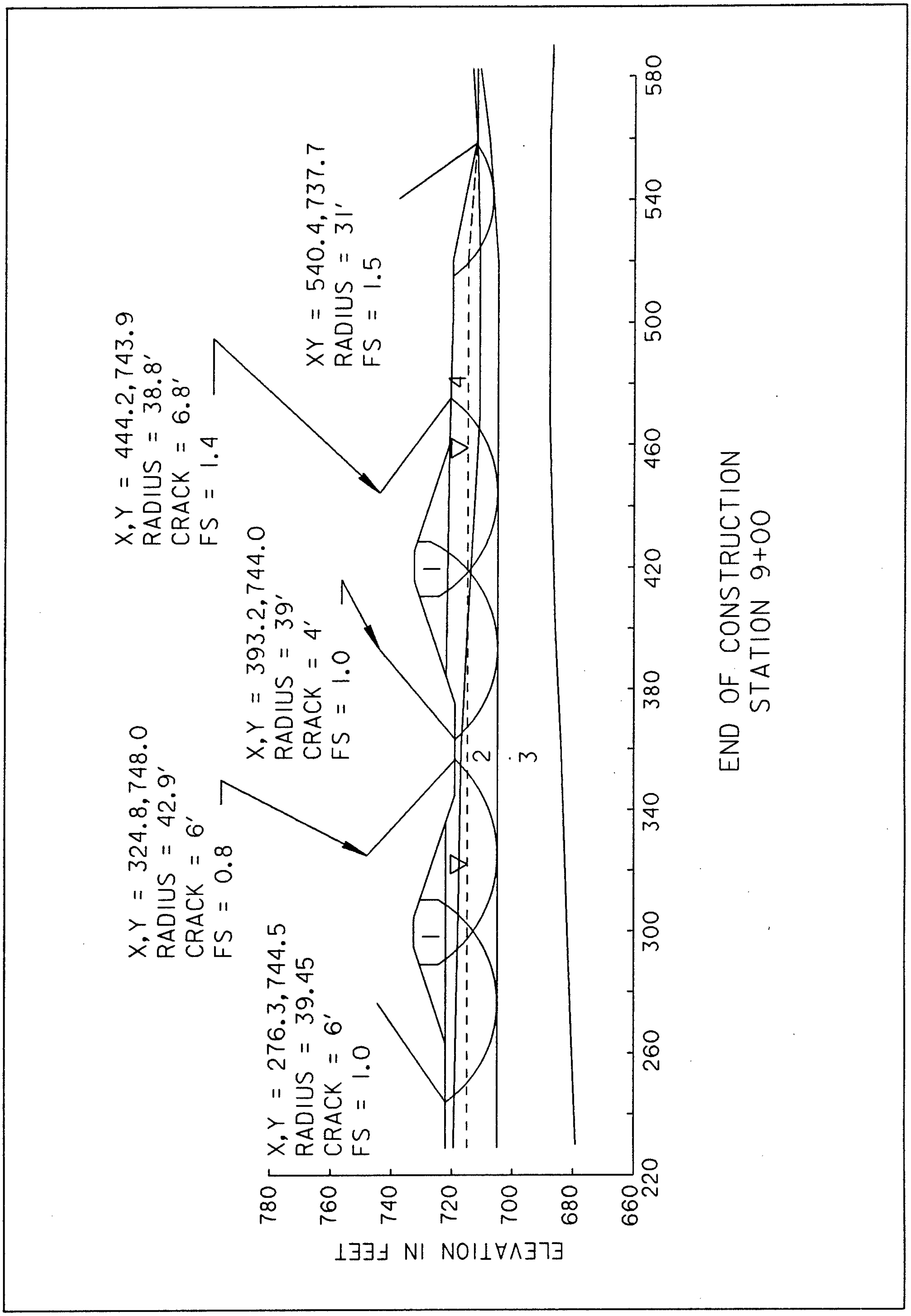
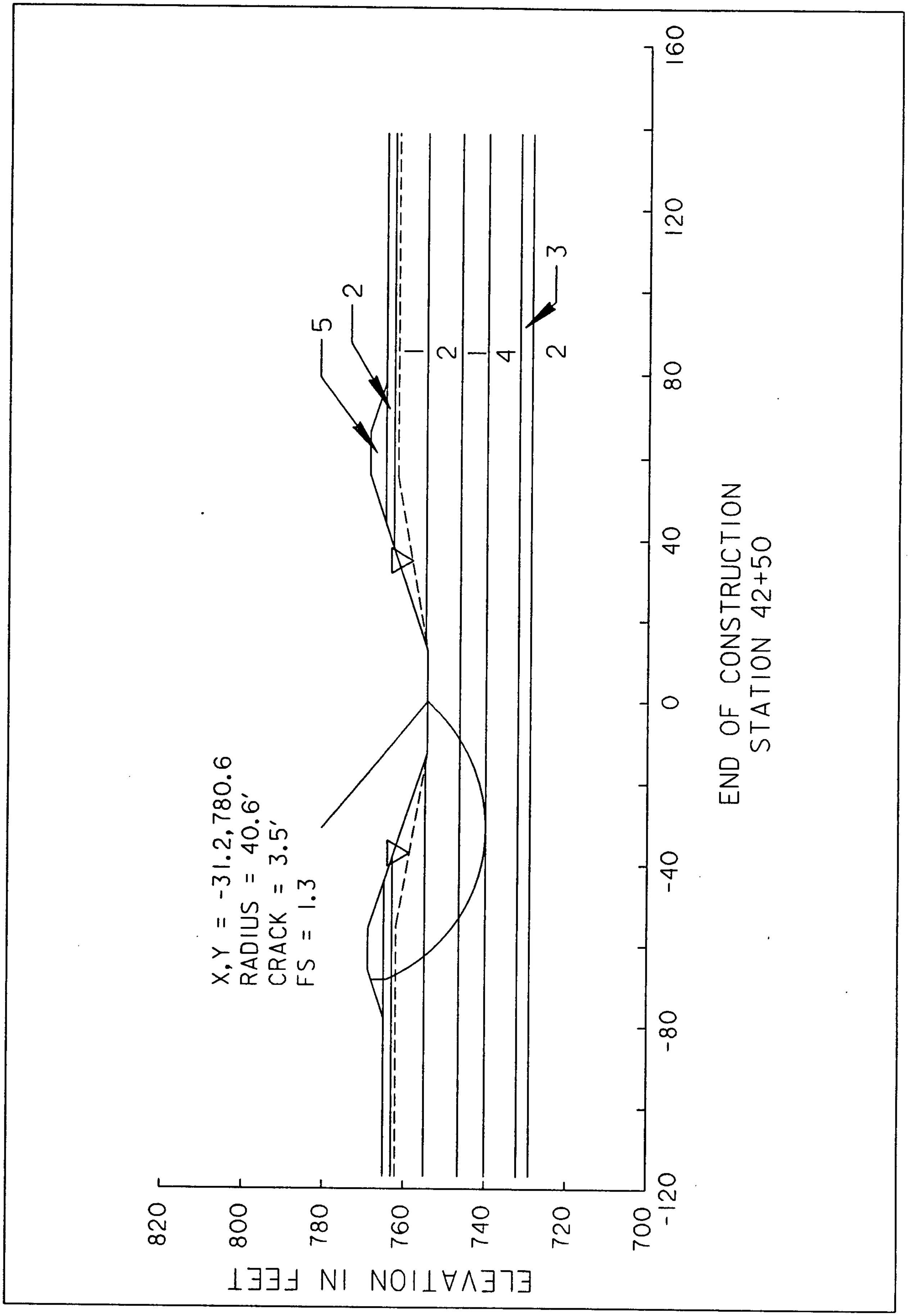
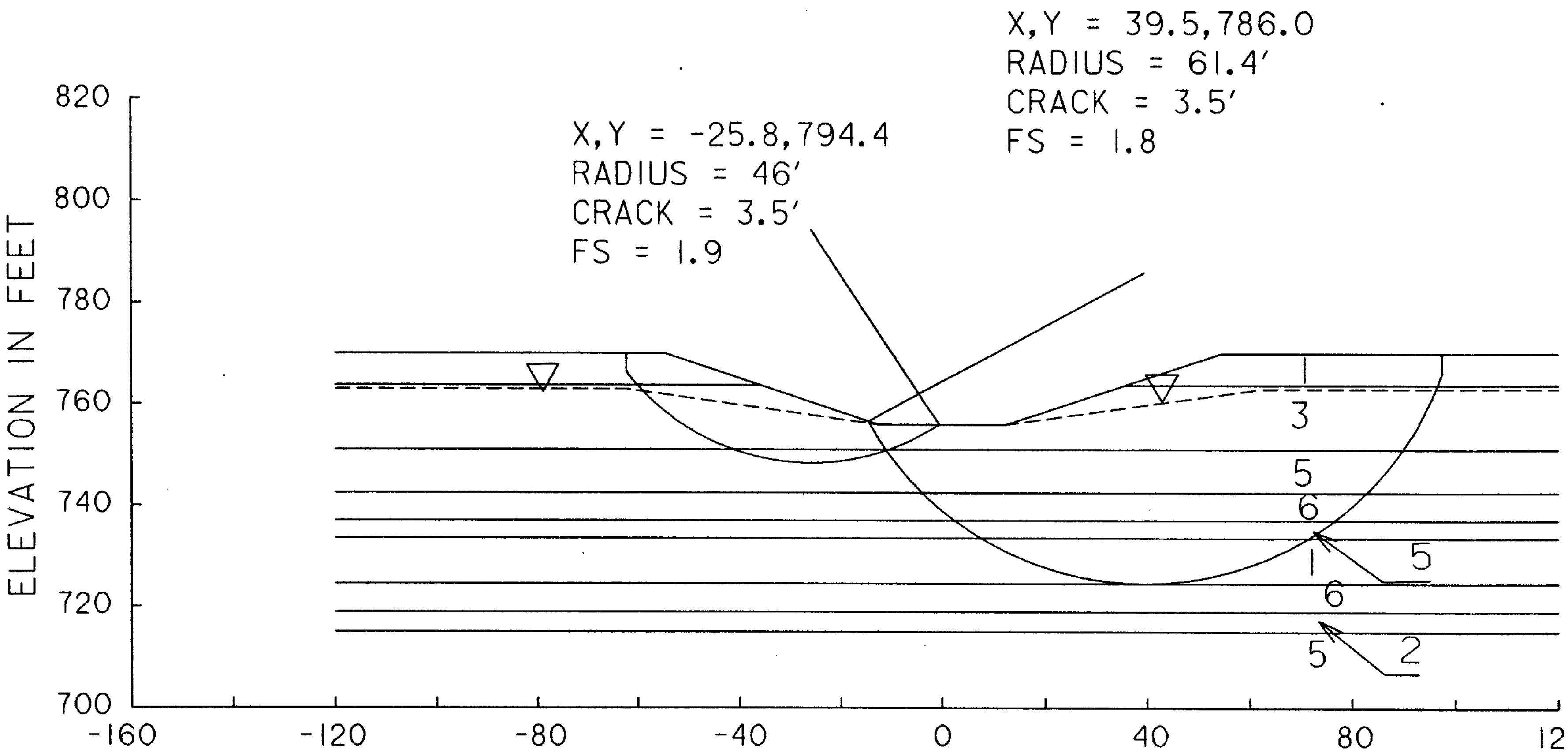

X,Y = 279.4,738.0
RADIUS = 30.9'
CRACK = 6.8'
FS = 1.3
X,Y = 421.0,738.0
RADIUS = 33.0'
CRACK = 6.8'
FS = 1.2
X,Y = 470.7,744.2
RADIUS = 42.2'
CRACK = 6.8'
FS = 1.1
1
2
3
END OF CONSTRUCTION
STATION 7+00
ELEVATION IN FEET
820
800
780
760
740
720
700
680
660
220
260
300
340
380
420
460
500

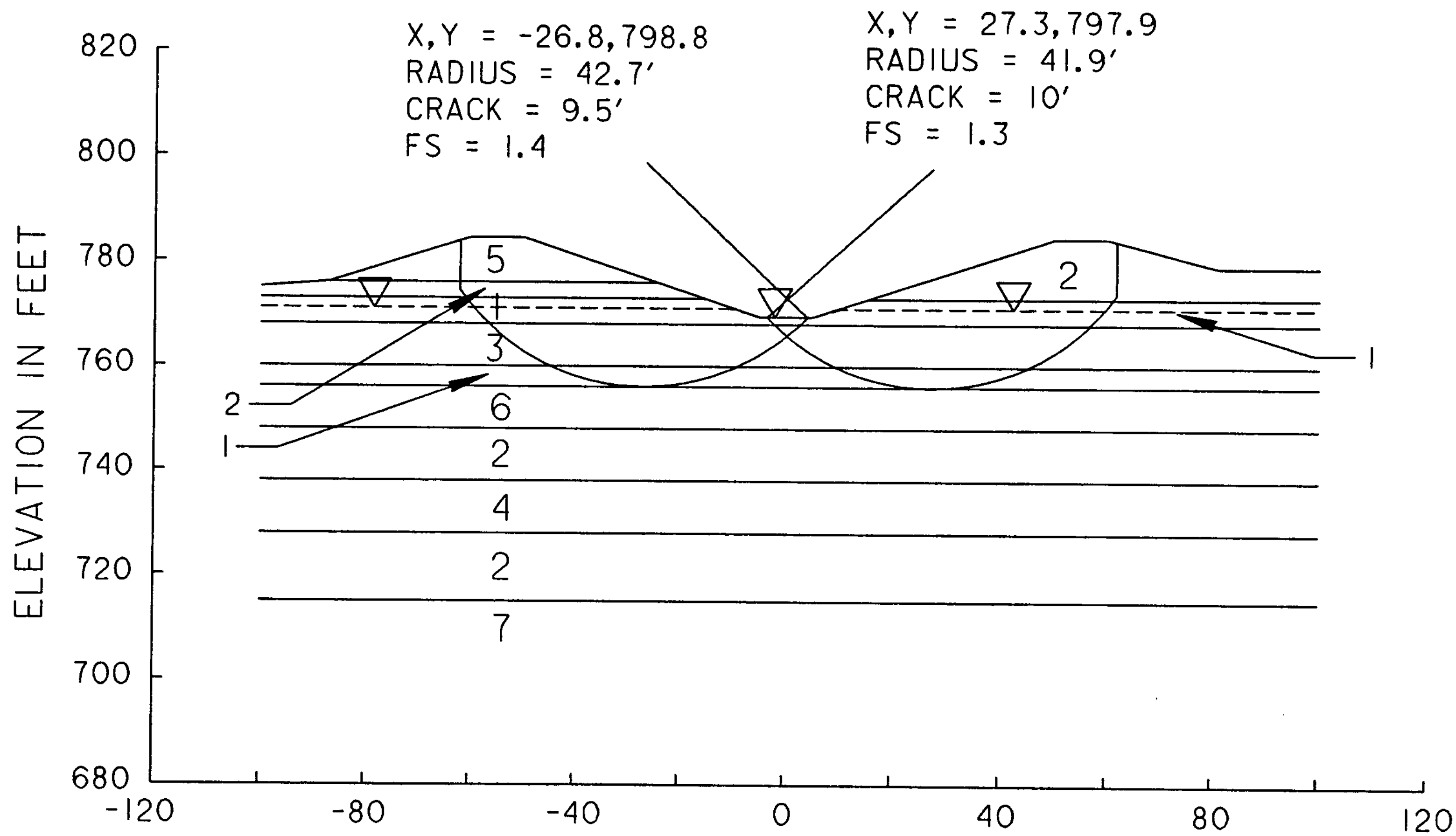
PLATE D-66


X,Y = 276.3,744.5
RADIUS = 39.45
CRACK = 6'
FS = 1.0
X,Y = 324.8,748.0
RADIUS = 42.9'
CRACK = 6'
FS = 0.8
X,Y = 393.2,744.0
RADIUS = 39'
CRACK = 4'
FS = 1.0
X,Y = 444.2,743.9
RADIUS = 38.8'
CRACK = 6.8'
FS = 1.4
XY = 540.4,737.7
RADIUS = 31'
FS = 1.5
END OF CONSTRUCTION
STATION 9+00
ELEVATION IN FEET
780
760
740
720
700
680
660
220
260
300
340
380
420
460
500
540
580

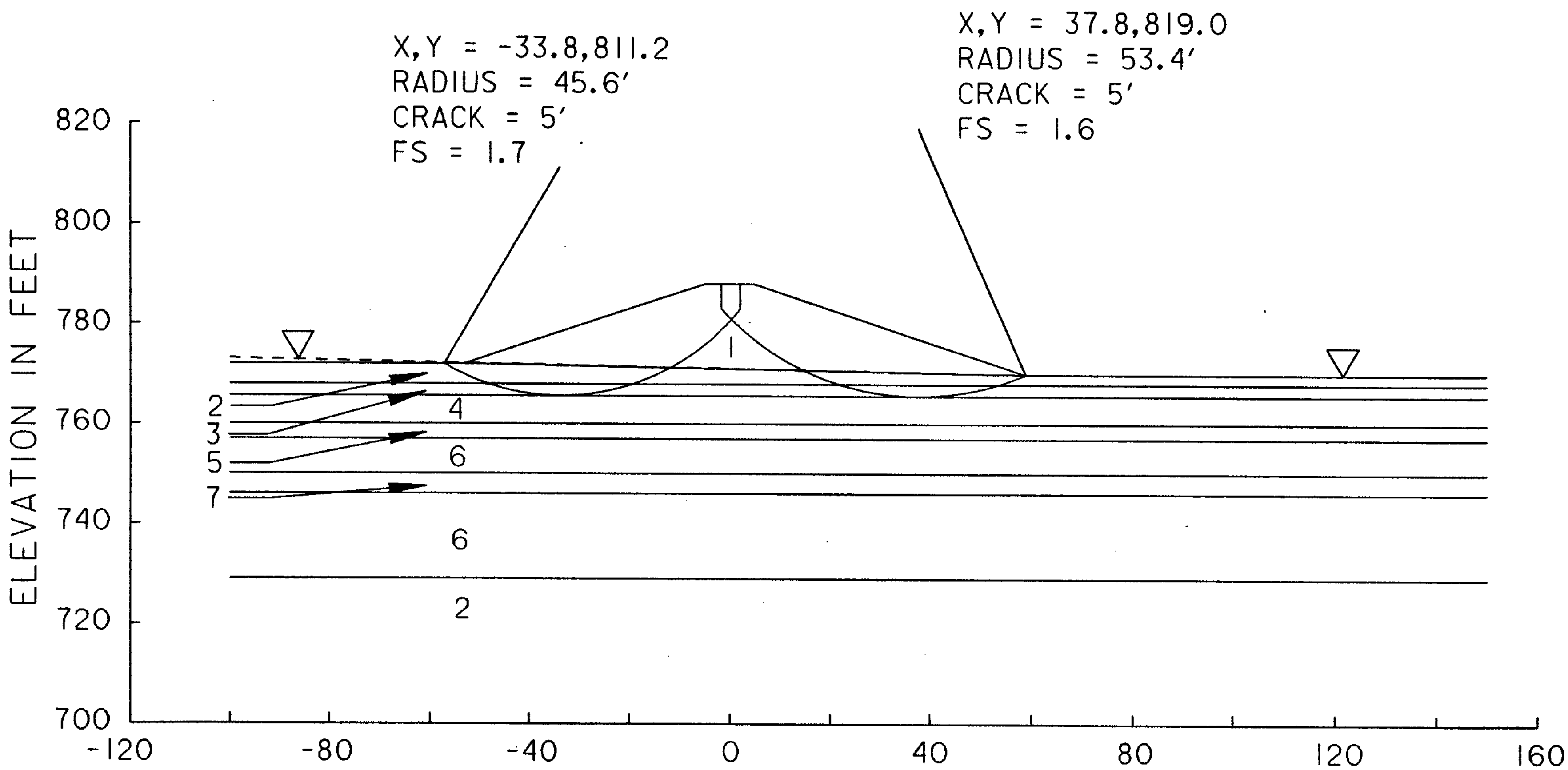

X,Y = -31.2,780.6
RADIUS = 40.6'
CRACK = 3.5'
FS = 1.3
5
2
3
1
2
1
4
2
ELEVATION IN FEET
700
720
740
760
780
800
820
-120
-80
-40
0
40
80
120
160
END OF CONSTRUCTION
STATION 42+50



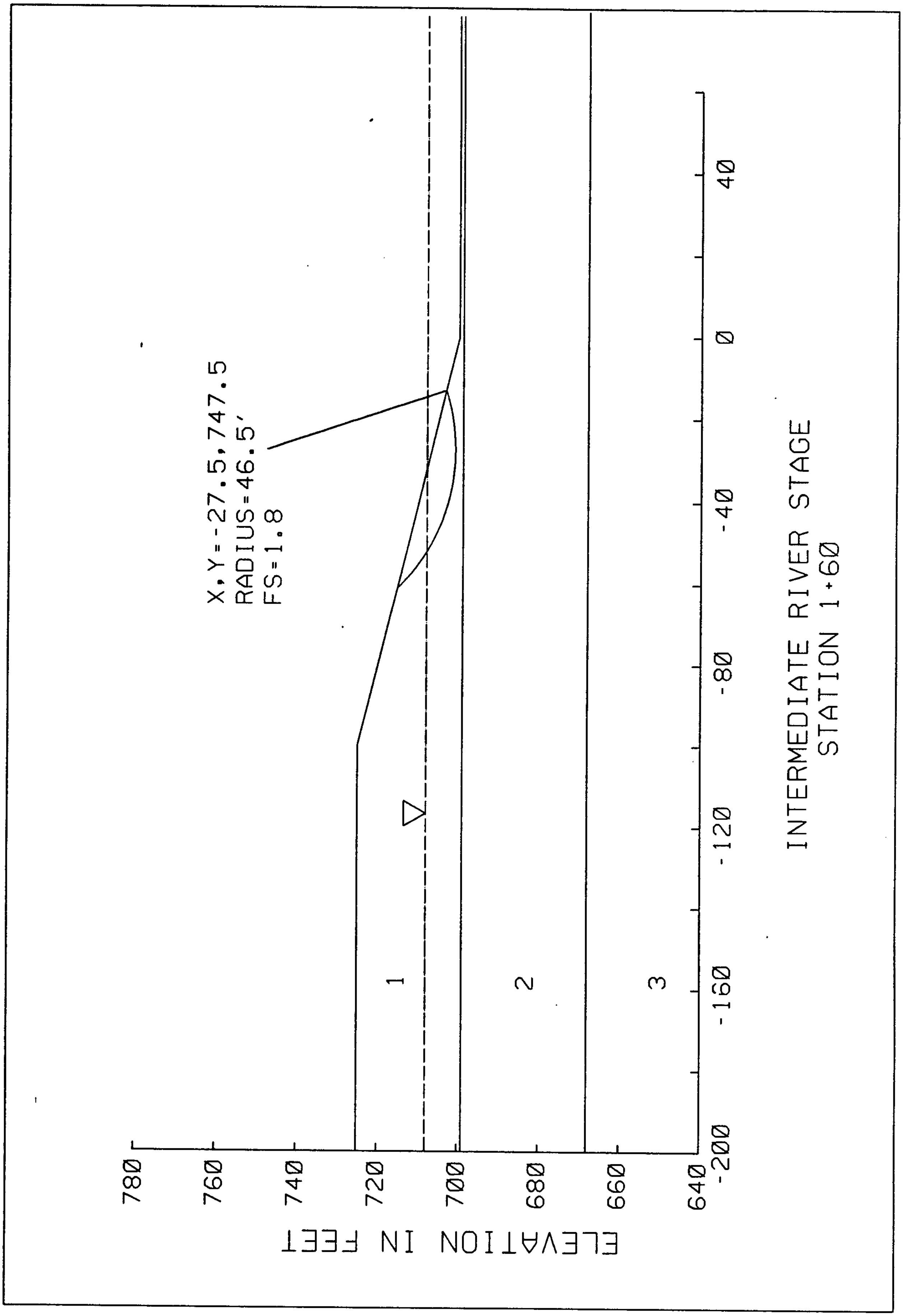
END OF CONSTRUCTION
UPSTREAM OF ENGLER
APPROX. STATION 48+00

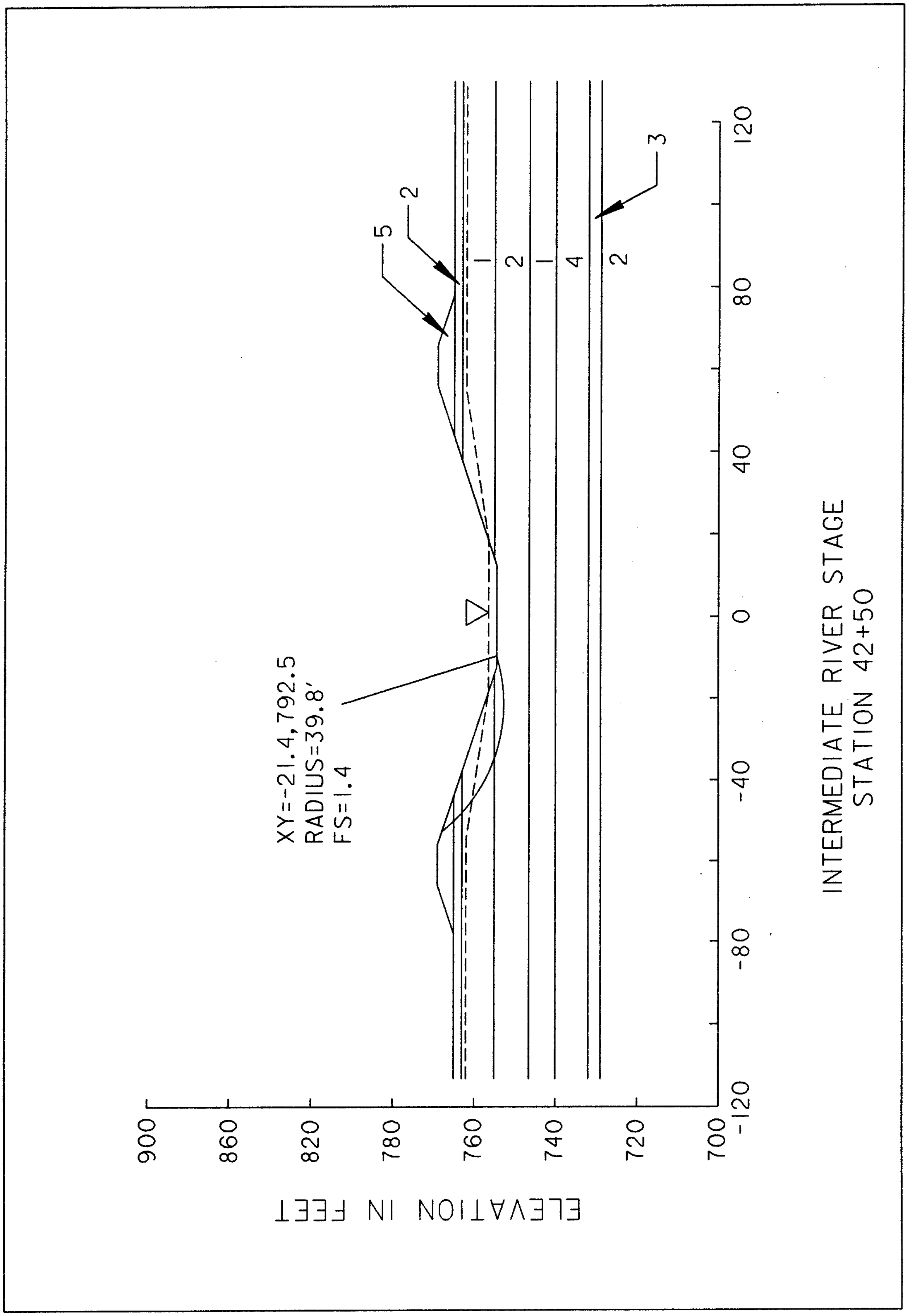


END OF CONSTRUCTION
UPSTREAM OF HWY 17
APPROX STATION 53+00



OUTLET E CROSS-SECTION
CASE I. END OF CONSTRUCTION


X,Y=-27.5,747.5
RADIUS=46.5'
FS=1.8
INTERMEDIATE RIVER STAGE
STATION 1+60
ELEVATION IN FEET
780
760
740
720
700
680
660
640
-200
-160
-120
-80
-40
0
40
1
2
3



INTERMEDIATE RIVER STAGE
STATION 42+50
XY=-21.4,792.5
RADIUS=39.8'
FS=1.4
ELEVATION IN FEET
900
860
820
780
760
740
720
700
-120
-80
-40
0
40
80
120
5
2
3
1
2
1
4
2

PLATE D-73

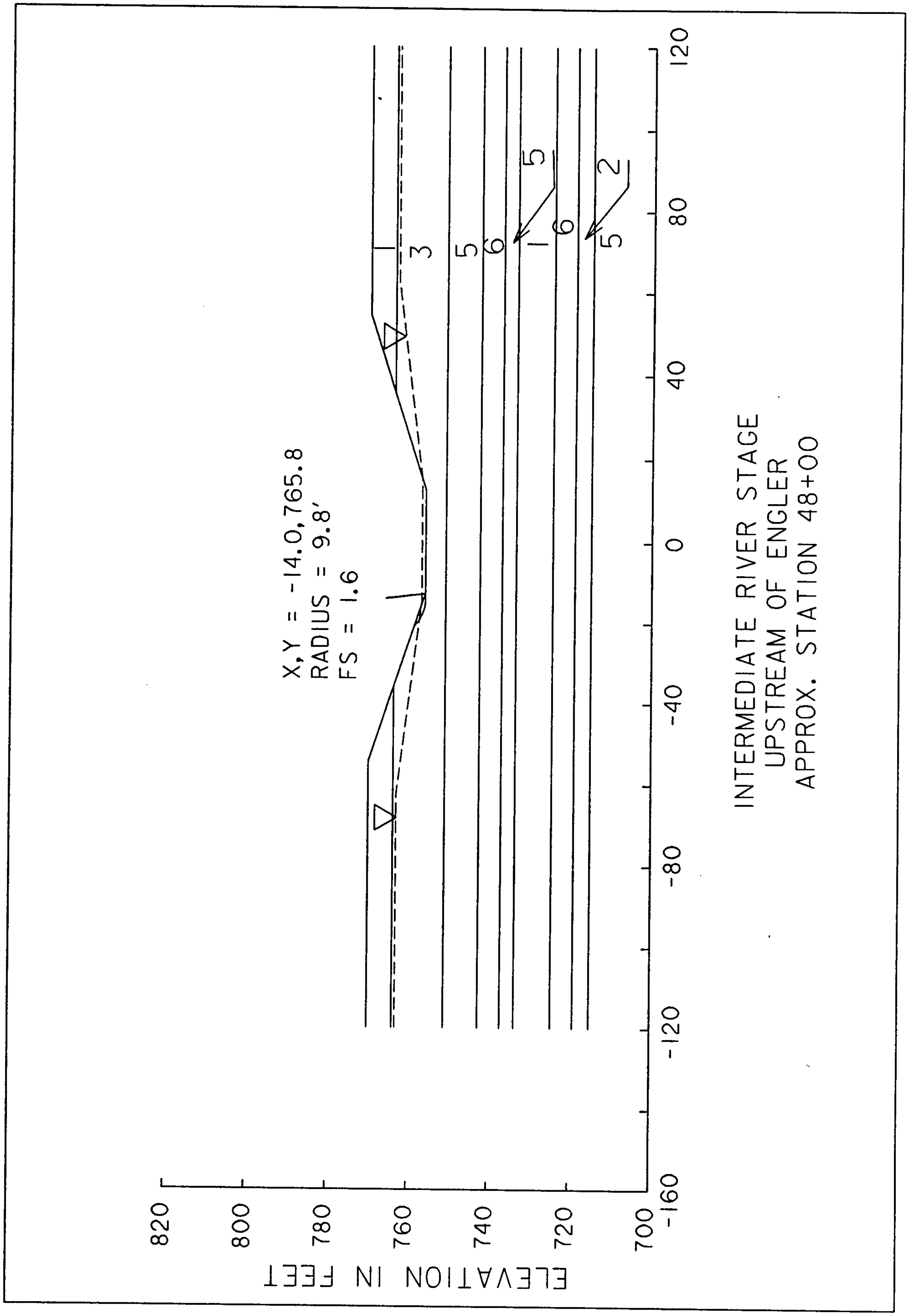
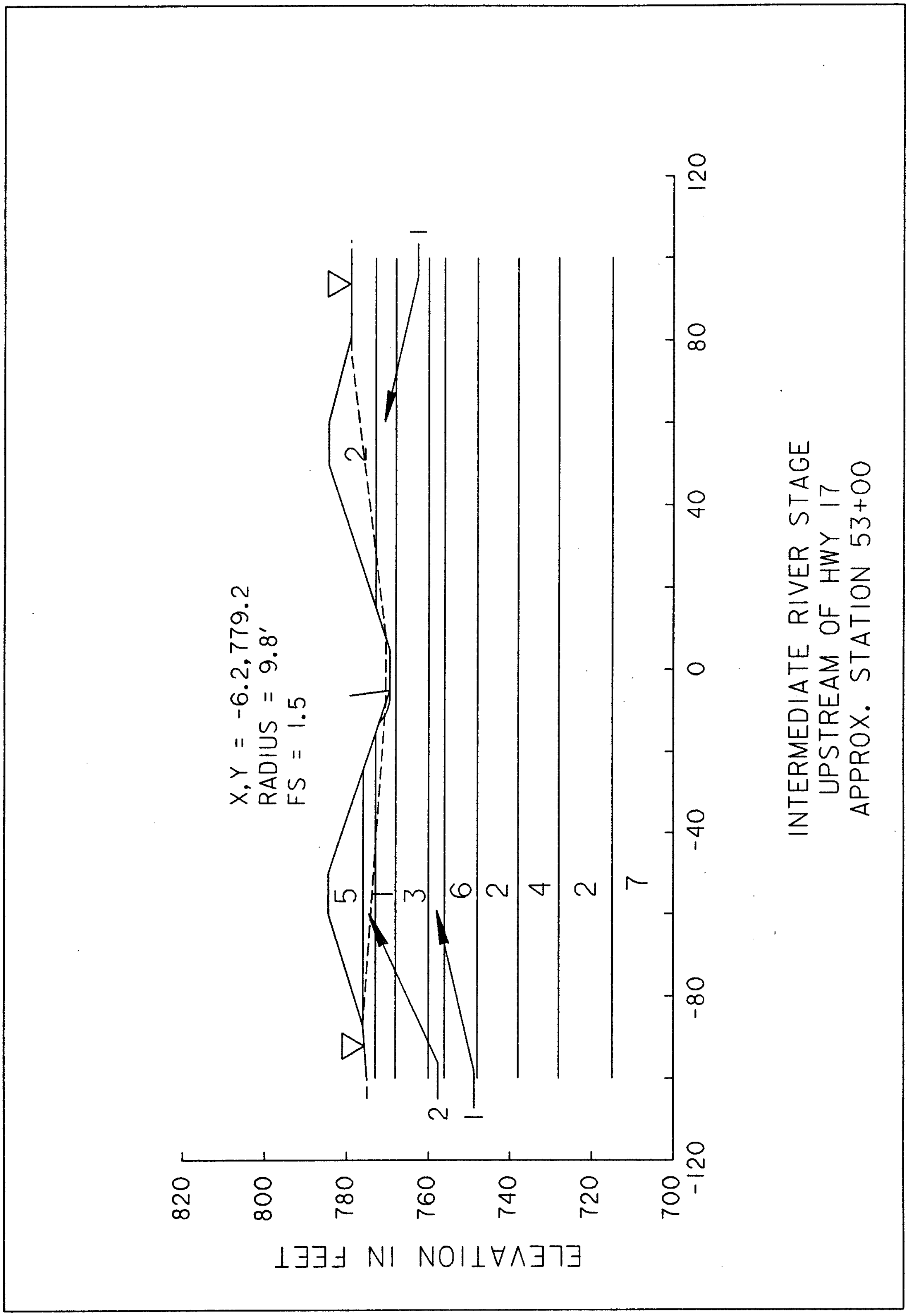
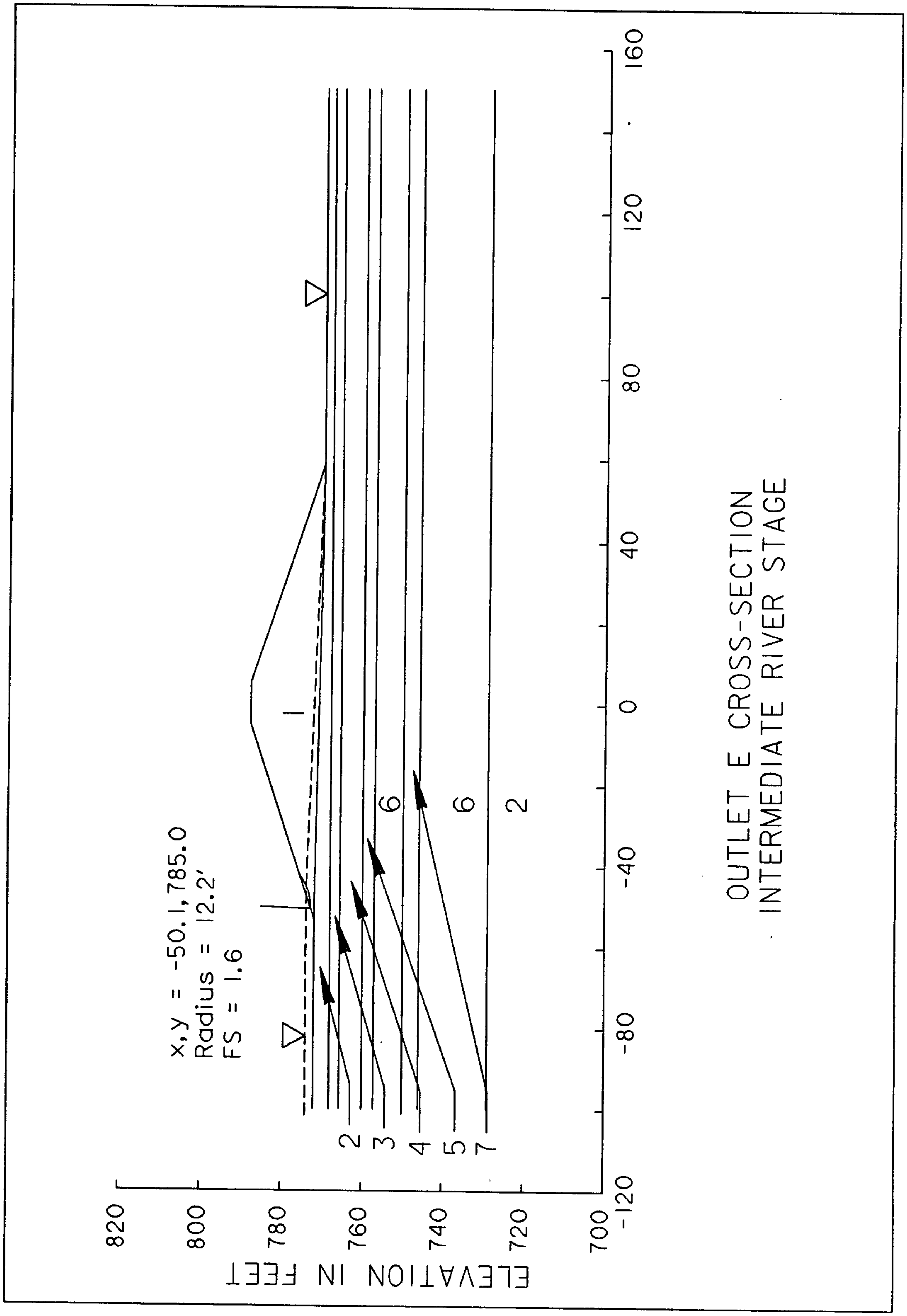
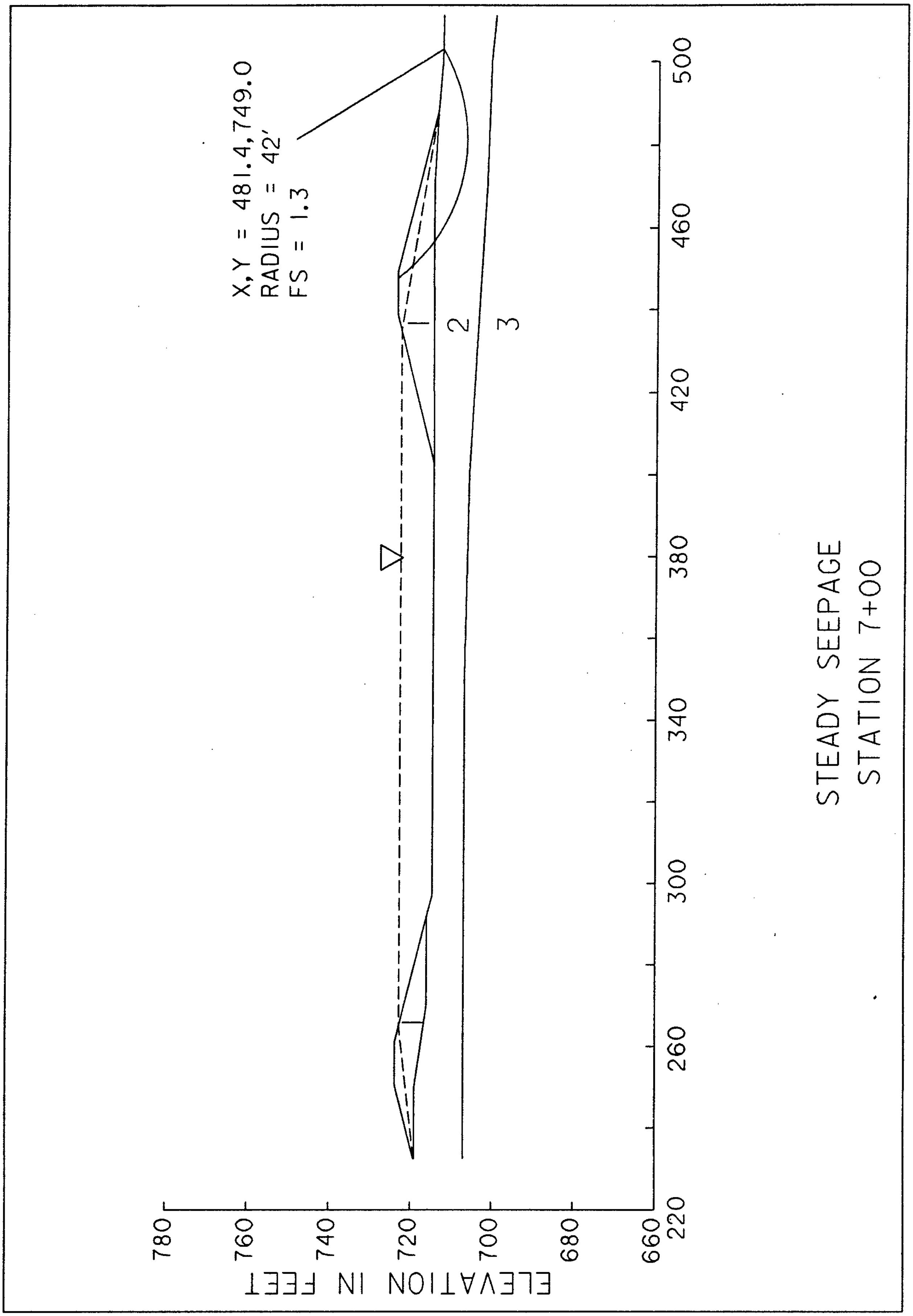

X,Y = -14.0,765.8
RADIUS = 9.8'
FS = 1.6
INTERMEDIATE RIVER STAGE
UPSTREAM OF ENGLER
APPROX. STATION 48+00
ELEVATION IN FEET
820
800
780
760
740
720
700
-160
-120
-80
-40
0
40
80
120
3
5
6
1
6
5
5
2

PLATE D-74

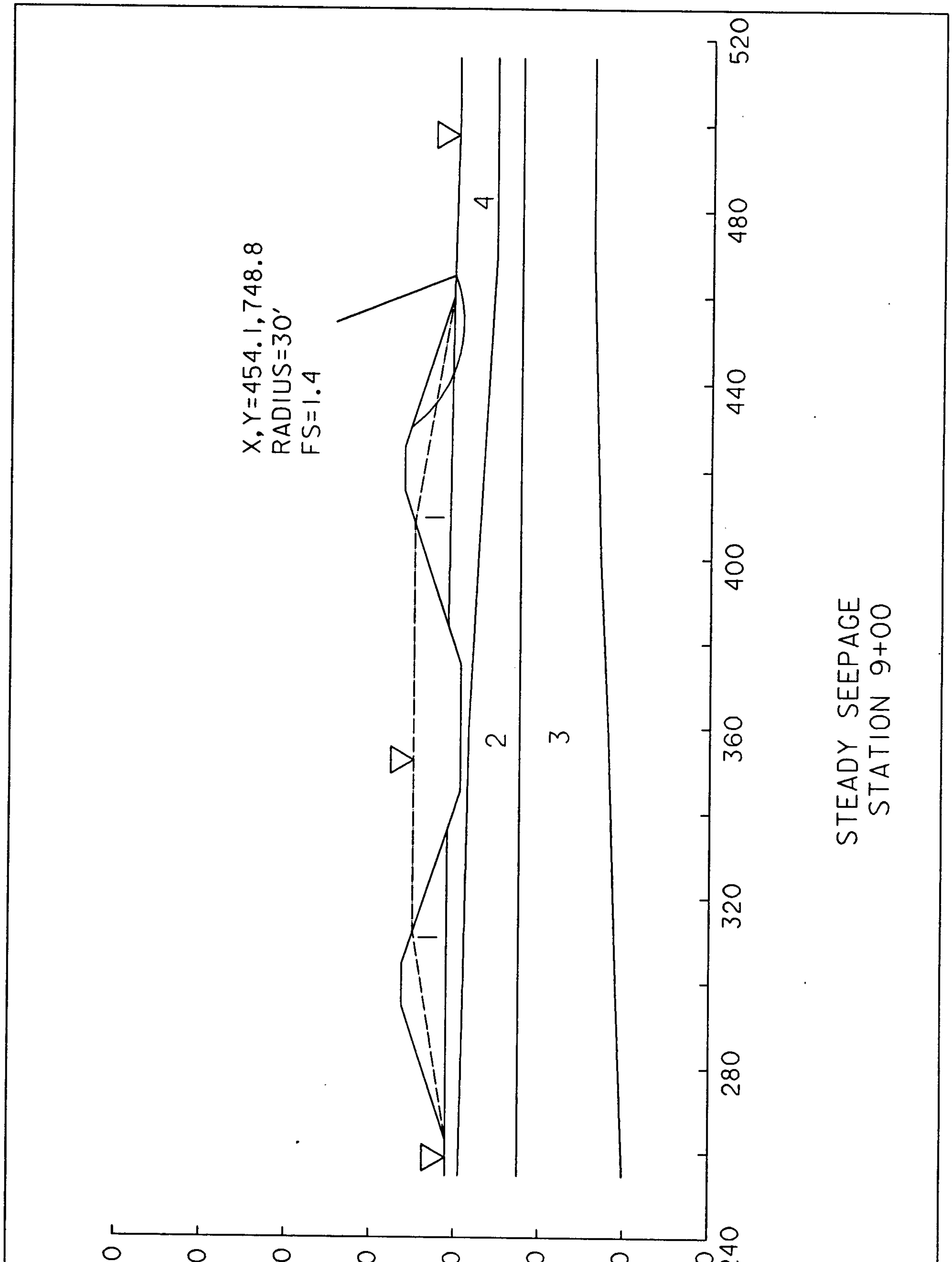

X,Y = -6.2,779.2
RADIUS = 9.8'
FS = 1.5
INTERMEDIATE RIVER STAGE
UPSTREAM OF HWY 17
APPROX. STATION 53+00
ELEVATION IN FEET
820
800
780
760
740
720
700
-120
-80
-40
0
40
80
120



OUTLET E CROSS-SECTION
INTERMEDIATE RIVER STAGE
x,y = -50.1,785.0
Radius = 12.2'
FS = 1.6
ELEVATION IN FEET
820
800
780
760
740
720
700
-120
-80
-40
0
40
80
120
160
1
2
3
4
5
6
6
7
2



X,Y = 481.4,749.0
RADIUS = 42'
FS = 1.3
1
2
3
STEADY SEEPAGE
STATION 7+00
ELEVATION IN FEET
780
760
740
720
700
680
660
220
260
300
340
380
420
460
500


X,Y=454.1,748.8
RADIUS=30'
FS=1.4
STEADY SEEPAGE
STATION 9+00
ELEVATION IN FEET
800
780
760
740
720
700
680
660
240
280
320
360
400
440
480
520
1
1
2
3
4

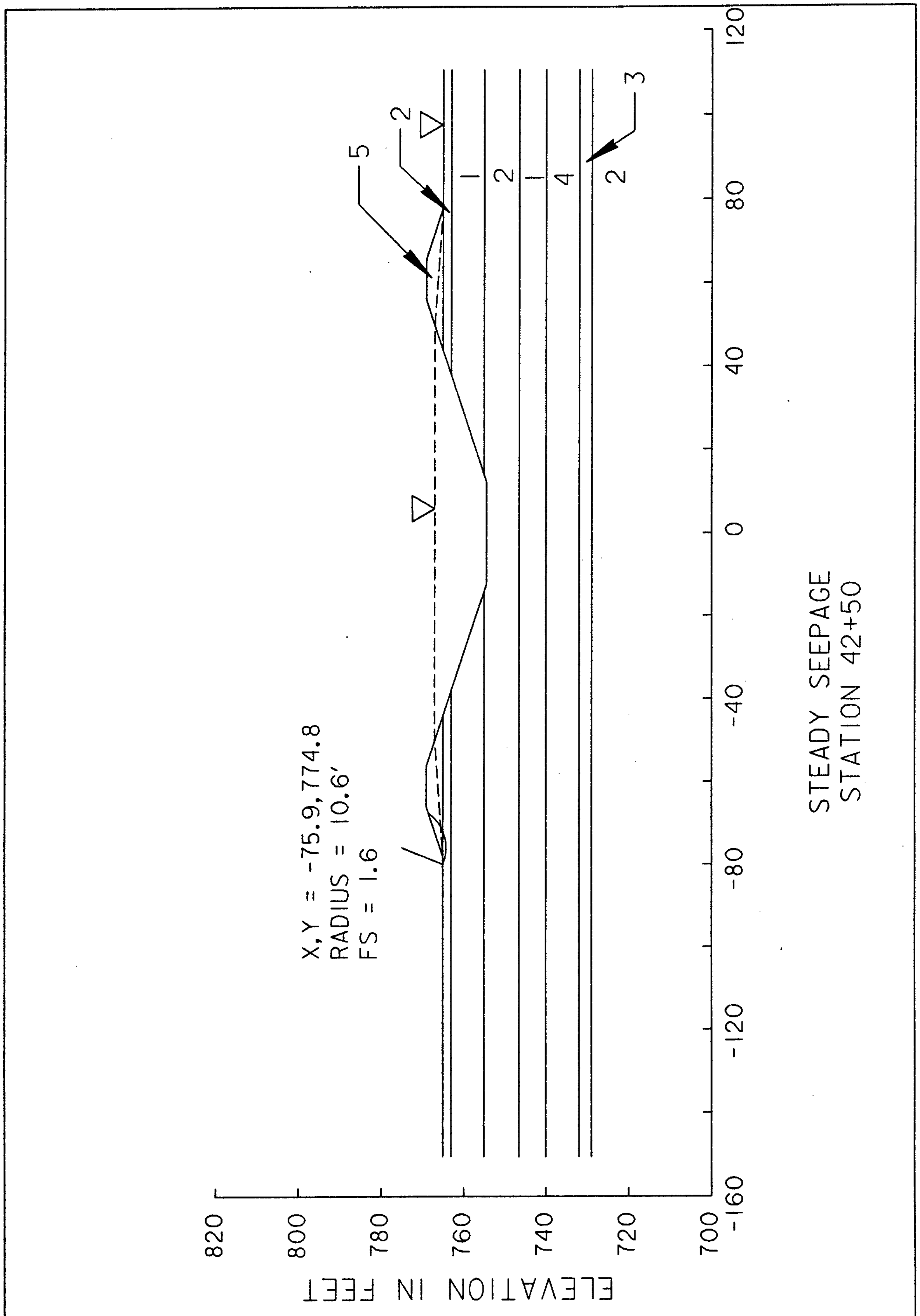

X,Y = -75.9,774.8
RADIUS = 10.6'
FS = 1.6
STEADY SEEPAGE
STATION 42+50
ELEVATION IN FEET
820
800
780
760
740
720
700
-160
-120
-80
-40
0
40
80
120
5
2
3
1
2
1
4
2

PLATE D-79

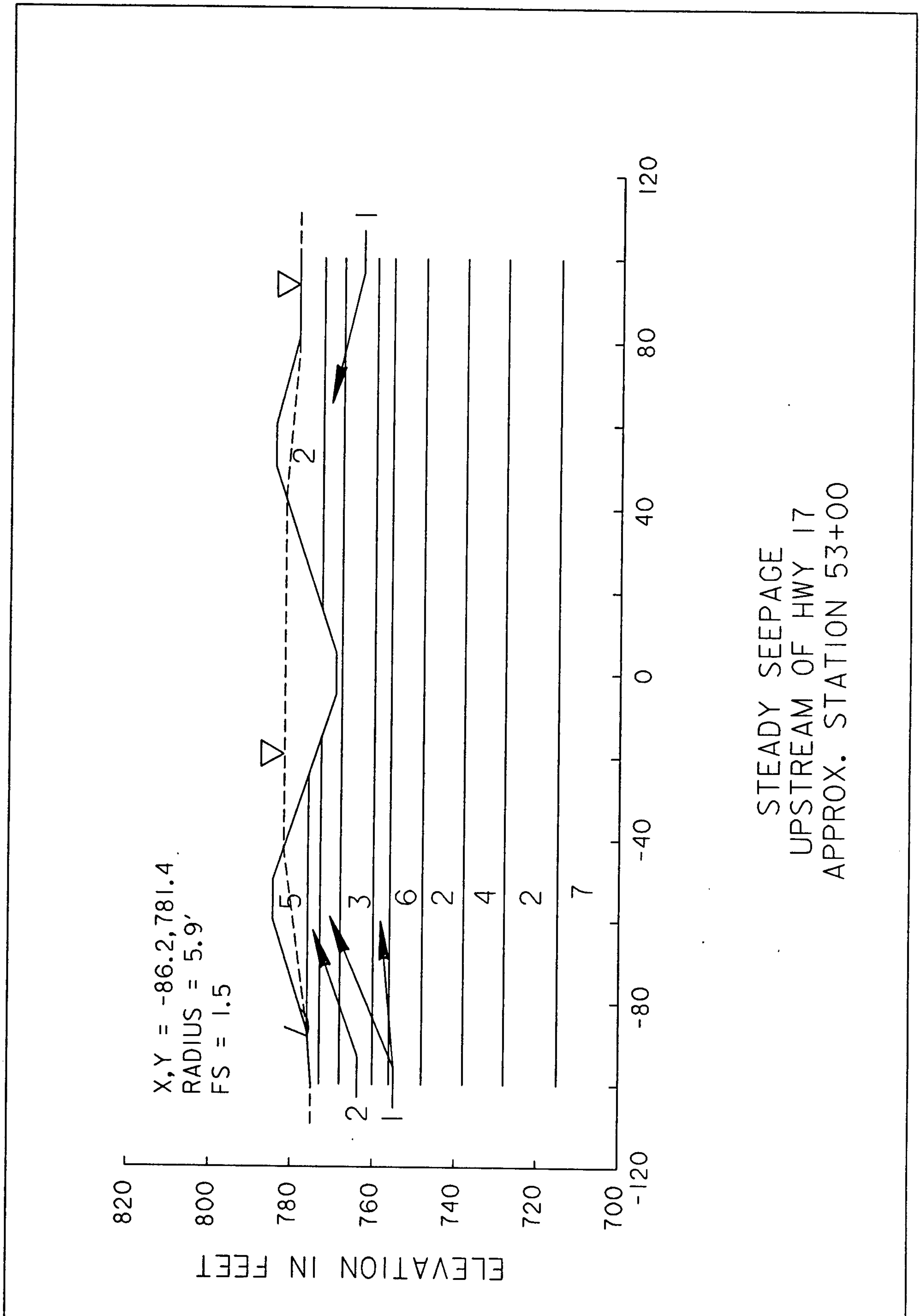
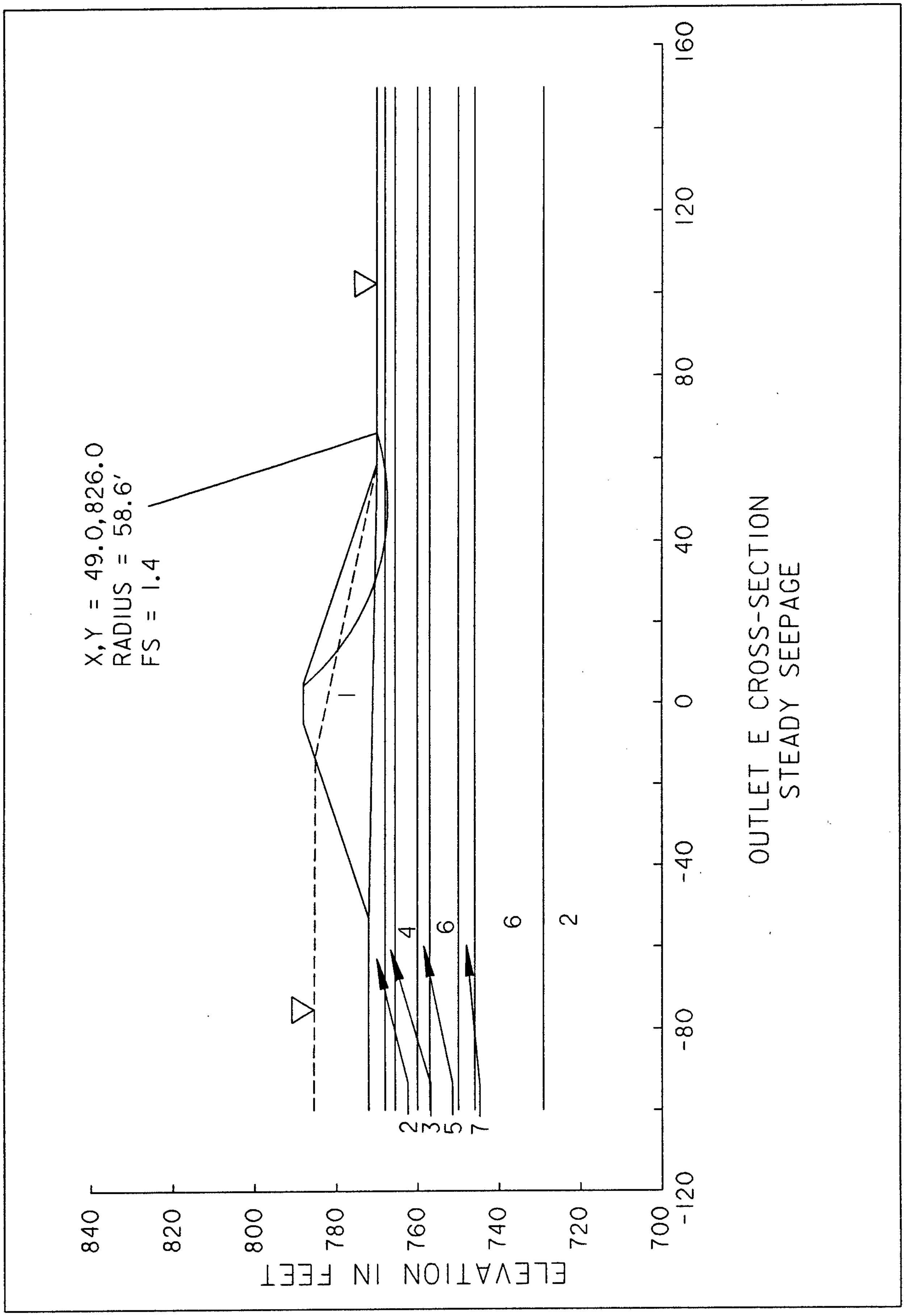

STEADY SEEPAGE
UPSTREAM OF HWY 17
APPROX. STATION 53+00
X,Y = -86.2,781.4
RADIUS = 5.9'
FS = 1.5
ELEVATION IN FEET
820
800
780
760
740
720
700
-120
-80
-40
0
40
80
120
5
3
6
2
4
2
7
2
1
2
1

PLATE D-80



X,Y = 49.0,826.0
RADIUS = 58.6'
FS = 1.4
OUTLET E CROSS-SECTION
STEADY SEEPAGE
ELEVATION IN FEET
840
820
800
780
760
740
720
700
-120
-80
-40
0
40
80
120
160
1
2
3
4
5
6
7

FOUNDATION SETTLEMENT OF LEFT LEVEE PRISM FROM
APPROX. STA. 6+00 TO 8+00 (downstream of ds #1)

Primary Consolidation of CL-OL and OH layers based on approximate soil stratigraphy of borings 92-174M, 92-197M and 92-198M

Soil Type	Approx. Elevation (ft)	Thickness of Layer (ft)	SPT	Average Moisture Content (%)	Average Liquid Limit	
	719					
CL-OL		6	1	37	45	ALL RESULTS FROM
	713					JAR SAMPLES
OH		8	1-3	168	159	
	705					

Compute compression index Cc based on the following correlation CL-OL

Cc = 0.009(LL-10) Cc = 0.32 (Terzaghi & Peck, 1967)
where LL = 45%

ASSUME A VOID RATIO eo = 1.2 (Terzaghi & Peck, 1967)

ASSUME A VOID RATIO eo = 3.0
For a soft organic clay, eo => 2.5-3.2 (Das,1990) OH

Compute compression index Cc based on the following correlation

Cc = 0.0115wn Cc = 1.9 (Das,1990)
where wn = insitu water content = 168%

CALCULATION OF PRIMARY CONSOLIDATION SETTLEMENT
ASSUMING A NORMALLY CONSOLIDATED MATERIAL

Depth Below G.S. (ft)	Increase in σv' due to levee (psf)	Effective Vertical Stress before levee (psf)	Primary Consolidation Settlement
			S = [CcH/(1+eo)] log [(po+delta p)/po]
1	1087	48	
2	1075	95	
3	1064	143	S = (0.32*6'/(1+1.2))*log((143+1064)/143)
4	1052	190	S = 0.81 ft
5	1040	238	
6	1027	286	
7	1015	333	
8	1002	381	
9	989	428	
10	977	476	S = (1.9*8'/(1+3.0))*log((476+977)/476)
11	964	524	S = 1.84 ft
12	951	571	
13	938	619	
14	925	666	
15	913	714	
16	900	762	
17	887	809	
18	875	857	
19	862	904	
20	850	952	

TOTAL PRIMARY >>>>>>> S = 2.65 ft = 31.8 in
CONSOLIDATION SETTLEMENT

ASSUMPTIONS / ADDITIONAL INFORMATION
- secondary consolidation settlement is not included in the analysis since limited information is available (secondary consolidation can be signifcant in organic soils)
- the increase in effective vertical stress due to the levee prism was modeled as follows: levee height = 10 ft
  top width = 10 ft
  side slope = 1 on 4
  levee length = 200 ft
- stress increase computed using NCSVERT (I0016), linearly elastic, Boussinesq solution
- increase in effective vertical stress computed at levee centerline
- groundwater table at the ground surface (i.e., S=100%)
- assumed foundation gamma sat. = 110 pcf

FOUNDATION SETTLEMENT OF RIGHT LEVEE PRISM FROM
APPROX. STA. 6+00 TO 8+00 (downstream of ds #1)

Primary Consolidation of CL-OL and OH layers based on approximate soil stratigraphy of borings 92-174M, 92-197M and 92-198M

Soil Type	Approx. Elevation (ft)	Thickness of Layer (ft)	SPT	Average Moisture Content (%)	Average Liquid Limit	
	719					
CL-OL		6	1	37	45	ALL RESULTS FROM
	713					JAR SAMPLES
OH		8	1-3	168	159	
	705					

Compute compression index Cc based on the following correlation CL-OL

Cc = 0.009(LL-10) Cc = 0.32 (Terzaghi & Peck, 1967)
where LL = 45%

ASSUME A VOID RATIO eo = 1.2 (Terzaghi & Peck, 1967)

ASSUME A VOID RATIO eo = 3.0
For a soft organic clay, eo => 2.5-3.2 (Das,1990) OH

Compute compression index Cc based on the following correlation

Cc = 0.0115wn Cc = 1.9 (Das,1990)
where wn = insitu water content = 168%

CALCULATION OF PRIMARY CONSOLIDATION SETTLEMENT
ASSUMING A NORMALLY CONSOLIDATED MATERIAL

Depth Below G.S. (ft)	Increase in σv' due to levee (psf)	Effective Vertical Stress before levee (psf)	Primary Consolidation Settlement S = [CcH/(1+eo)]log [(po+delta p)/po]
1	555	48	
2	546	95	
3	535	143	S = (0.32*6'/(1+1.2))*log((143+535)/143)
4	524	190	S = 0.59 ft
5	511	238	
6	499	286	
7	485	333	
8	472	381	
9	459	428	
10	446	476	S = (1.9*8'/(1+3.0))*log((476+446)/476)
11	433	524	S = 1.09 ft
12	420	571	
13	408	619	
14	395	666	
15	384	714	
16	372	762	
17	361	809	
18	351	857	
19	341	904	
20	331	952	

TOTAL PRIMARY >>>>>>> S = 1.68 ft = 20.2 in
CONSOLIDATION SETTLEMENT

ASSUMPTIONS / ADDITIONAL INFORMATION
- secondary consolidation settlement is not included in the analysis since limited information is available (secondary consolidation can be signifcant in organic soils)
- the increase in effective vertical stress due to the levee prism was modeled as follows: levee height = 5 ft
  top width = 10 ft
  side slope = 1 on 4
  levee length = 200 ft
- stress increase computed using NCSVERT (I0016), linearly elastic, Boussinesq solution
- increase in effective vertical stress computed at levee centerline
- groundwater table at the ground surface (i.e., S=100%)
- assumed foundation gamma sat. = 110 pcf

FOUNDATION SETTLEMENT NEAR ENGLER BLVD.
DUE TO LOWERING OF THE WATER TABLE

Primary Consolidation of strata based on geologic profile developed from 90-134, 92-169, and 92-200

Strata	Soil Type	Liquid Limit (AVERAGE)	Plastic Limit (AVERAGE)	Moist. Content (AVERAGE)	SPT	Elevation (ft)
A.	SC-CL	35	17	23.9	2	766-751
B.	CL-ML	26	19	32.1	1	746-740
C.	CL	31	19	37.1	0	733-728

For Undisturbed Clays, the following empirical correlation exists

			A.	B.	C.
Cc = 0.009(LL-10)	(Terzaghi & Peck)	Cc =	0.23	0.15	0.19

Compute in situ void ratio eo based on the following correlations

			A.	B.	C.
(for all clays)		Assuming Cc =	0.23	0.15	0.19
Cc = 0.156eo + 0.0107		eo =	1.41	0.89	1.15
Cc = 0.3(eo-0.27)	(Hough)	eo =	1.04	0.77	0.90
Cc = 0.75(eo-0.5)	(Soils with low plasticity)	eo =	0.81	0.70	0.75
Void ratio range for soft clay (0.9 - 1.4)		Average eo =	1.08	0.79	0.94

Results of Consolidation Tests

Strata	Soil Type	Boring	Sample	Elevation (ft)	OCR	eo	Cc	Cr
A.	SC	90-134	1	763.7-762.4	3.5	0.63	0.13	0.01
A.	SC	92-200	1	762.2-760.2	4.3	1.09	0.4	0.03
A.	SC	90-134	2	758.7-756.7	1.7	1.37	0.51	0.07
A.	SC	90-134	3	753.7-751.7	1.8	0.67	0.14	0.01
			Average Values		2.8	0.94	0.30	0.03

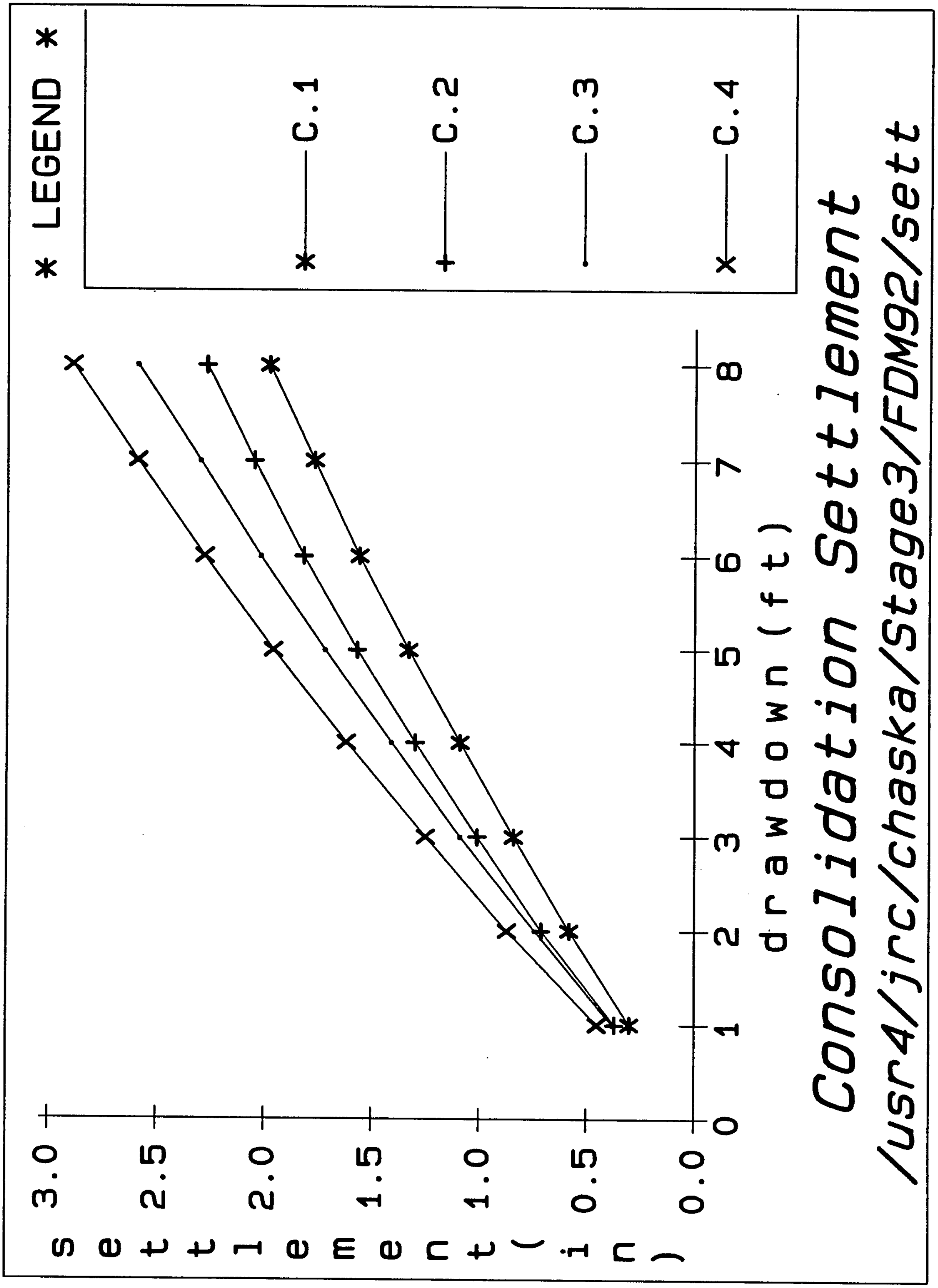
Filename: usr4/cwb/chaska3/engler/sett/drawd1.w20
Date: 10-NOV-1993

Settlement at Engler and Highway 17

elevations(ft)	soil type	Case 1	Case 2	Case 3	Case 4
766–751	sc-cl	Cr=0.03 e0=0.94	Cr=0.07 e0=1.37	Cr=0.03 e0=0.94	Cr=0.07 e0=1.37
751–746	sands				
746–740	cl-ml	Cc=0.15 e0=0.79	Cc=0.15 e0=0.79	Cc=0.15 e0=0.79	Cc=0.15 e0=0.79
740–733	sands				
733–726	cl	Cc=0.19 e0=0.94	Cc=0.19 e0=0.94	Cc=0.19 e0=0.94	Cc=0.19 e0=0.94
726–719	sm-ml	Cc=0.04 e0=0.24	Cc=0.04 e0=0.24	Cc=0.19 e0=0.94	Cc=0.19 e0=0.94
719–715	cl	Cc=0.08 e0=0.40	Cc=0.08 e0=0.40	Cc=0.19 e0=0.94	Cc=0.19 e0=0.94
715–709	sands				
709–705	cl	Cc=0.04 e0=0.24	Cc=0.04 e0=0.24	Cc=0.19 e0=0.94	Cc=0.19 e0=0.94
705–700	sands				

gamma moist=120 pcf
gamma sat=125 pcf

file:/usr/jrc/chaska/stage3/seepage/engler/section.dgn


* LEGEND *
C.1
C.2
C.3
C.4
Consolidation Settlement
/usr4/jrc/chaska/Stage3/FDM92/sett
drawdown (ft)
settlement(in)
0
1
2
3
4
5
6
7
8
0.0
0.5
1.0
1.5
2.0
2.5
3.0

FOUNDATION SETTLEMENT OF LEVEE NEAR HIGHWAY 17 DROP STRUCTURE
Primary Consolidation of CL & CH layers based on boring 80-32M

Soil Type	Depth Below G.S. (ft)	Thickness of Layer (ft)	SPT (#/ft)	M.C. (%)	Atterberg Limits LL (%)	Atterberg Limits PL (%)
	5					
CL & CH		2	2	33		
	7					
	8					
CL		3	2	28	41	14
	11					
	14					
CL & CH		9	2	36	55	16
	23			32	39	15
				28		
				40		

ASSUME A VOID RATIO eo = 0.9
For a soft clay, eo => (0.9-1.4)
(Das,1990)

NOTE: 92-171M, sample 2, consolidation test results for a CL material with similar index properties provided suspect information

Compute compression index Cc based on the following correlation (EM 1110-1-1904)
Cc = 0.012wn (for wn=34%) Cc = 0.41

CALCULATION OF PRIMARY CONSOLIDATION SETTLEMENT
ASSUMING A NORMALLY CONSOLIDATED CLAY

Depth Below G.S. (ft)	Increase in ov' due to levee (psf)	Effective Vertical Stress before levee (psf)	Primary Consolidation Settlement
			S = [CcH/(1+eo)] log [(po+delta p)/po]
2	1378	250	
3	1374	375	
4	1367	500	
5	1358	625	
6	1346	750	S = (0.41*2'/(1+0.9))*log((750+1346)/750)
7	1333	875	S = 0.19 ft
8	1319	1000	
9	1303	1125	S = (0.41*3'/(1+0.9))*log((1187+1295)/1187)
10	1287	1250	S = 0.21 ft
11	1270	1313	
12	1253	1375	
13	1236	1438	
14	1218	1500	
15	1200	1563	
16	1182	1626	
17	1164	1688	
18	1146	1751	S = (0.41*9'/(1+0.9))*log((1782+1155)/1782)
19	1128	1813	S = 0.42 ft
20	1110	1876	
21	1092	1939	
22	1074	2001	
23	1057	2064	
24	1039	2126	
25	1022	2189	

TOTAL PRIMARY >>>>>>> S = 0.82 ft = 10 in.
CONSOLIDATION SETTLEMENT

ASSUMPTIONS / ADDITIONAL INFORMATION
- Cc = 0.41 is a representative average value for clay soils in this area
- secondary consolidation was not considered
- the increase in effective vertical stress due to the levee prism was modeled as follows: normal loading
  levee height = 11.5 ft
  top width = 10 ft
  levee length = 120 ft
- increase in effective vertical stress computed at levee centerline
- groundwater table 10 ft below the ground surface (based on boring 80-32m)
- gamma sat. = 125 pcf (foundation soil) gamma moist = 120 pcf (levee fill)

OUTLET E SETTLEMENT

Primary Consolidation of CL layer between elevation 768.2 - 765.6
based on boring 80-33M

Soil Type	Liquid Limit	Plastic Limit	Moist. Content	SPT
CL	47	15	35.9	1-2

For Remolded Clays, the following empirical correlations exist

Cc = 0.007(LL-10)	(Terzaghi & Peck)	Cc = 0.259
Cc = 0.007(LL-7)	(Skempton)	Cc = 0.28

Compute in situ void ratio eo based on the following correlations
(for all clays)

Cc = 0.156eo + 0.0107		eo = 1.6
Cc = 1.15(eo-0.27)	(Nishida)	eo = 0.5

Void ratio range for soft clay (0.9 - 1.4)   Average eo = 1.05

CHECK OF PRIMARY CONSOLIDATION SETTLEMENT VS. CSETT RESULTS

Stress increase under centerline of Levee Prism (Das 1983)
delta p = qo/pi [((B1+B2)/B2)(alpha1+alpha2)-(B1/B2)alpha2]

alpha1 = arctan((B1+B2)/z)-arctan(B1/z)
alpha2 = arctan(B1/z)

Effect of Levee Prism

gamma = 120 pcf	B1 = 5 ft	alpha1 = 0.48962 radians
H = 18 ft	B2 = 54 ft	alpha2 = 1.03038 radians
qo = gamma(H) = 2160 psf	z = 3 ft	delta p1= 2152.48 psf

Effect of Seepage Berm

gamma = 120 pcf	B1 = 191 ft	alpha1 = 0.00114 radians
H = 5 ft	B2 = 15 ft	alpha2 = 1.55509 radians
qo = gamma(H) = 600 psf	z = 3 ft	delta p2= 300 psf

Effect of Seepage Berm

gamma = 120 pcf	B1 = 56 ft	alpha1 = 9.5e-06 radians
H = 5 ft	B2 = 0.01 ft	alpha2 = 1.51728 radians
qo = gamma(H) = 600 psf	z = 3 ft	delta p3= 299.98 psf

delta p = delta p1+delta p2-delta p3 = 2152.5 psf

ASSUMING A NORMALLY CONSOLIDATED CLAY

S = [CcH/1+eo] log po+delta p/po >>>>>>> S = 0.373 ft

CSETT Results >>>>>>> S = 0.362 ft

Settlement under levee centerline (@ x=0)

file:usr4/cwb/chaska3/settle/outlete.w20

RESULTS OF CSANDSET FOR OUTLET E

SETTLEMENT (in.)

METHOD		LEVEE CENTER	RIVERWARD SLOPE	LANDWARD SLOPE	SEEPAGE BERM
A. Terzaghi		---	---	---	---
B. Teng		3.56	6.5	6.5	---
C. Alpan		3.72	0.98	0.98	0.36
D. Elastic Theory:	Rigid	0.88	0.43	0.43	0.22
	Center	0.95	0.46	0.46	0.24
	Average	0.8	0.39	0.39	0.2
E. D'Appolonia (1968)		0.6	0.35	0.35	0.2
F. D'Appolonia (1970)		0.32	0.18	0.18	0.06
G. Peck and Bazaraa		2.51	4.12	4.12	3.18
H. Schmertmann (1970)		5.55	---	---	---
I. Schmertmann (1978)		2.34	---	---	---
J. Schultz & Sherif		1.52	0.37	0.37	0.12
K. Meyerhof		2.96	3.44	3.44	3.18
L. Peck, Hanson, Thornburn		5.62	4.5	4.5	3.66
M. Bowles		---	---	---	2.36
N. NAVFAC DM 7.1		4.24	2.35	2.35	4.09
O. Oweis:	Rigid	---	---	---	---
	Center	---	---	---	---
	Edge	---	---	---	---
	AVERAGE	2.54	2.01	2.01	1.49
FOOTING WIDTH (ft)		10	54	54	150
FOOTING LENGTH (ft)		200	200	200	200
LOAD INTENSITY, q (tsf)		1.08	0.54	0.54	0.3
EMBEDMENT DEPTH (ft)		0	0	0	0
DEPTH OF WATER TABLE BELOW GROUND SURFACE (ft)		0.5	0.5	0.5	0.5
AVERAGE SPT VALUE OF PERVIOUS STRATUM		2	2	2	2

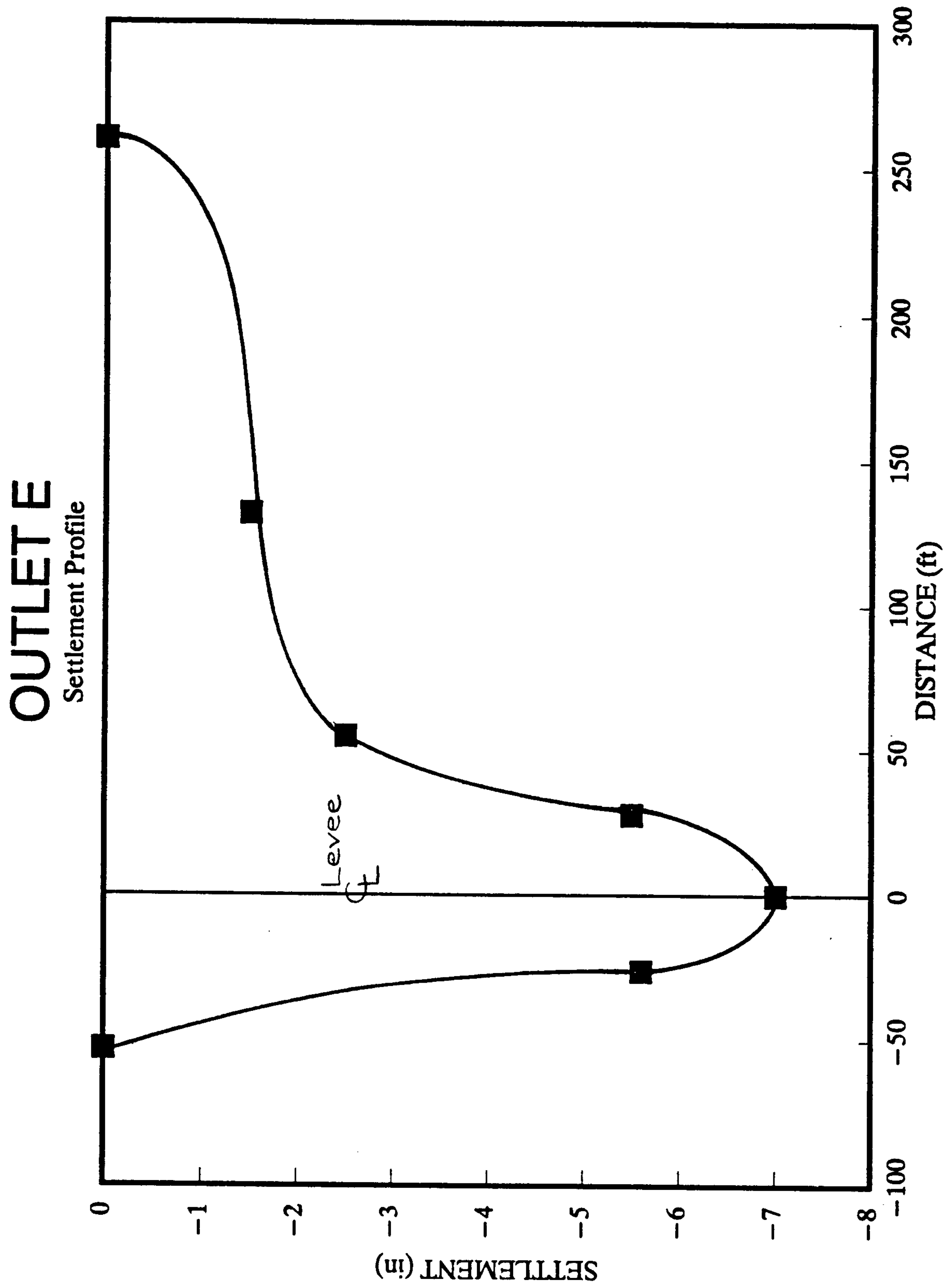
ASSUMPTIONS MADE IN SETTLEMENT ANALYSIS OF PERVIOUS STRATA

- Embankment loading approximated by a series of footing loads
- Immediate settlement restricted to a depth of 10 ft. below the natural ground surface, below the 10 ft. depth effects of the embankment loading on the higher blow count material would lead to an overly conservative estimate
- 10 ft. pervious stratum, SPT value of 2, includes the 2.6 ft. CL layer, therefore an immediate & consolidation settlement was computed for this layer

SETTLEMENT PROFILE
Consolidation + Average Immediate Settlement

Distance (ft)	Settlement (in)
-53	0
-26	5.6
0	7
28	5.5
55	2.5
132	1.5
260	0

FILENAME:usr4/cwb/chaska3/settle/oecss.w20



OUTLET E
Settlement Profile
SETTLEMENT (in)
0
-1
-2
-3
-4
-5
-6
-7
-8
DISTANCE (ft)
-100
-50
0
50
100
150
200
250
300
Levee
℄

file:/usr4/jrc/chaska/STAGE3/FDM92/writeup/platematdis

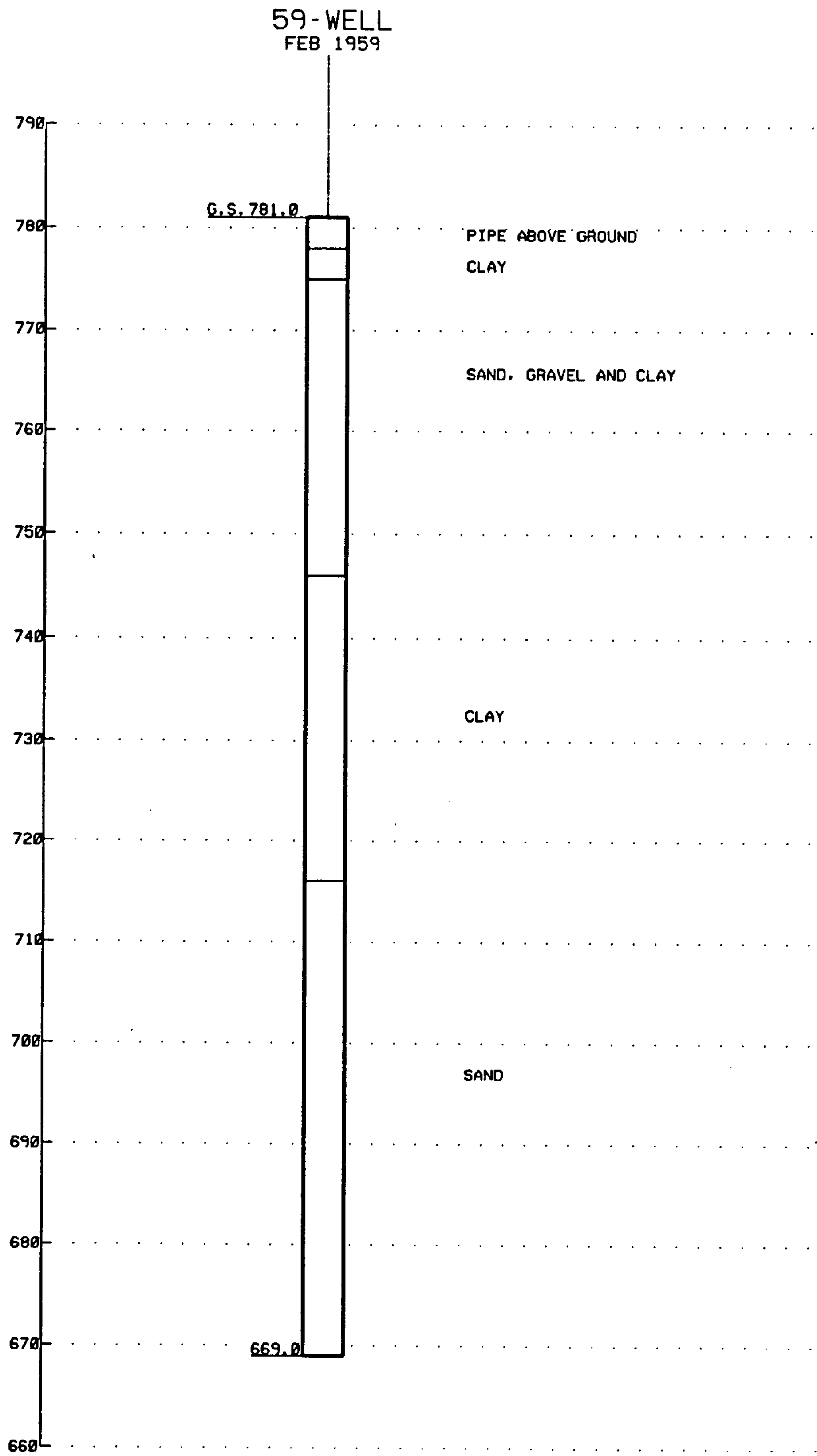
****

Chaska Stage 3 Material Distribution
Used in determining quantities of usable fill from required excavation.
Does not account for material wasted during stripping and grubbing.

By Station

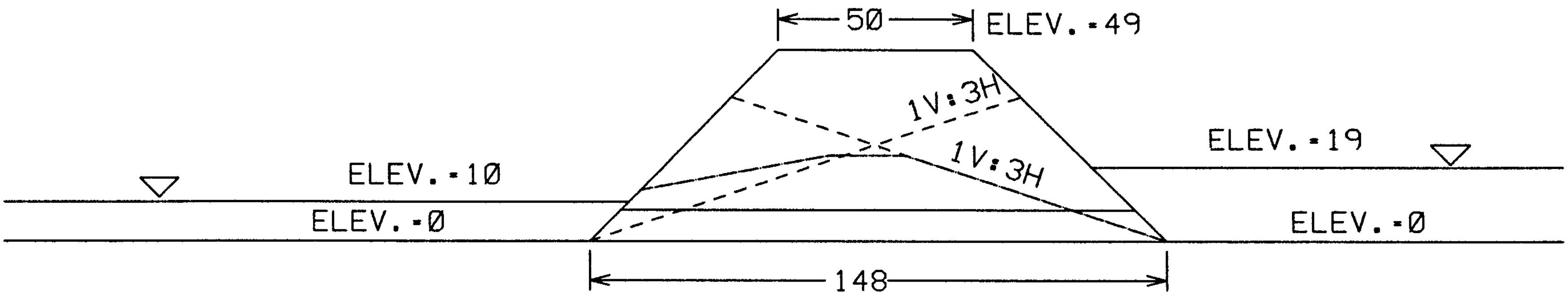
From	To	
0	650	assume water level at elev 715
		wet clays to be wasted(25%)
		Lime to be moved to west(MH is the lime)(75%)
		no usable excavation
650	1450	assume water at elev 719
		10% wasted
		80% random fill
		10% pervious fill
		all material below water level wasted(except pervious)
1450	2600	assume water at elev 730
		30% pervious
		70% random
2600	3000	assume water at elev 745
		10% pervious
		80% random
		10% wasted
		all material below water level wasted
3000	3300	assume water at elev 745
		30% impervious
		40% random
		30% wasted
		all material below water level wasted
3300	4000	assume water at elev 752
		20% impervious
		30% random
		50% wasted
		all material below water level wasted
4000	4800	assume water at elev 760
		20% impervious
		50% random
		30% wasted
		all material below water level wasted
4800	6000	assume water at elev 770
		60% impervious
		30% random
		10% wasted
		all material below water level wasted

****



NOTES

1. GROUND SURFACE DETERMINED FROM 1984 TOPOGRAPHY.
2. 78 FEET OF 24" WELL CASING, 35 FEET OF 24" WELL SCREEN.
3. STATIC WATER LEVEL 17 INCHES ABOVE TOP OF PIPE.
4. WELL ABANDONED IN 1989.
5. LOCATED NORTH OF ENGLER BLVD. AND WEST OF COUNTY ROAD NO. 17.

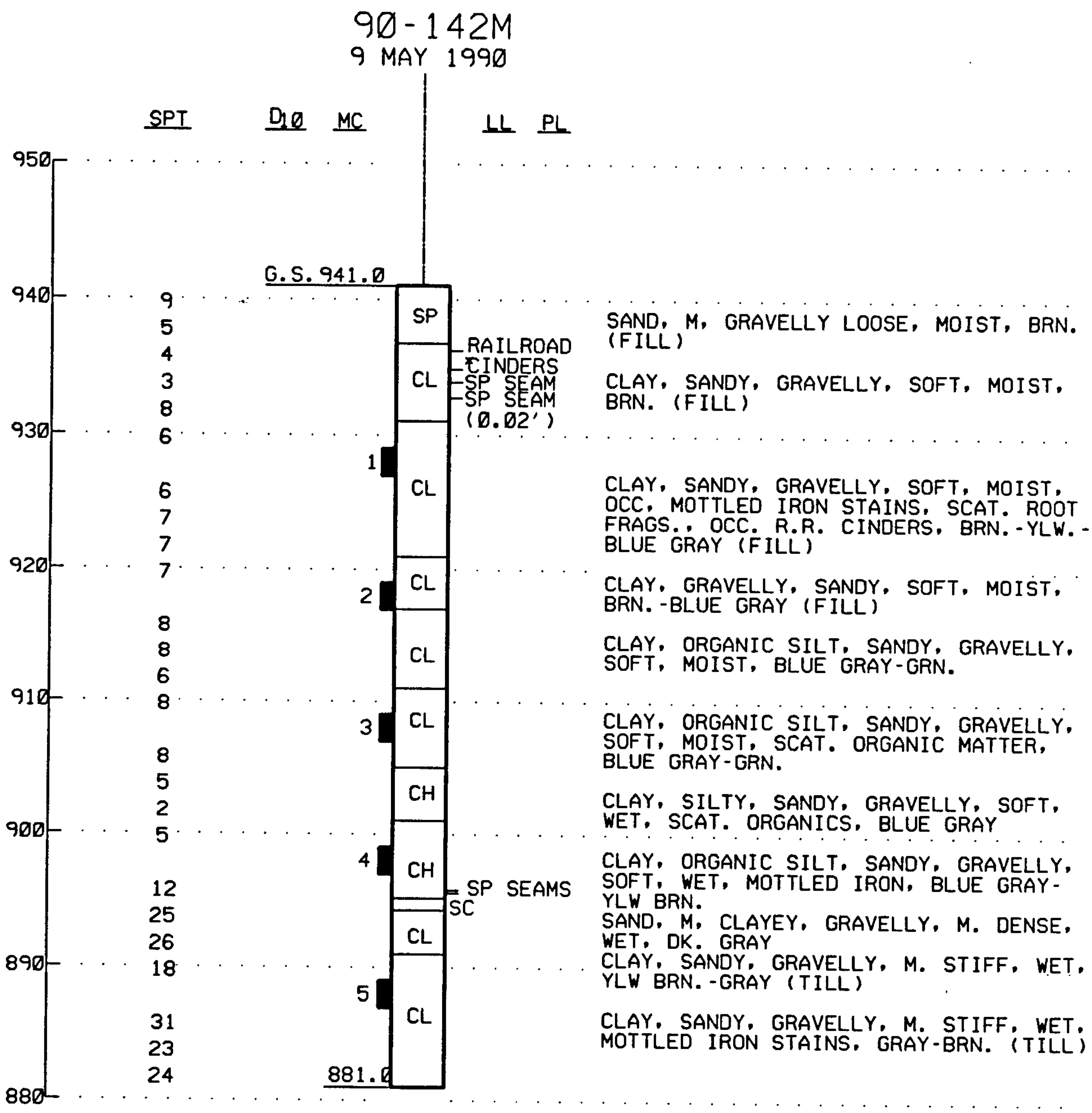


RR EMBANKMENT(1V:1H SLOPES)

INTERSECTION BETWEEN TWO 1V :3H SLOPES AT ELEV.=24.5 FEET

"DASH DOT DASH" LINE INDICATES 1V:3H UPSTREAM SLOPE, 20 FOOT TOP WIDTH, AND 1V:5.5H DOWNSTREAM SLOPE, TOP ELEV.=22

CULVERT DIMENSIONS:153 FEET LONG, 14 FEETWIDE, 8 FEET HIGH, SOUTH INVERT ELEV=894.87,NORTH INVERT ELEV.=894.66



NOTES

1. WATER LEVEL NOT ENCOUNTERED.
2. HOLLOW STEM AUGER ADVANCED TO EL. 883.0'.
3. FIVE 2" UNDISTURBED SAMPLES TAKEN FROM THE PILOT BORING.
4. HOLE BACKFILLED WITH CEMENT-BENTONITE GROUT.

Boring No.	Sample No.	Sample Type	Depth (ft)	Atterberg Limits	Moisture Content	Mechanical Analysis	Hydro-meter	Specific Gravity	Triaxial Shear Q	Triaxial Shear R bar	Unconfined Compression	Consolidation Load&Reb.
80 - 30 M	3	jar	9.2									
80 - 30 M	4	jar	15.0									
80 - 30 M	6	jar	21.2									
80 - 30 M	8	jar	31.5									
80 - 30 M	10	jar	41.4									
80 - 32 M	1	jar	1.5									
80 - 32 M	3	jar	6.6									
80 - 32 M	5	jar	11.0									
80 - 32 M	6	jar	13.9									
80 - 32 M	7	jar	16.1									
80 - 32 M	8	jar	19.4									
80 - 32 M	10	jar	21.8									
80 - 32 M	11	jar	23.1									
80 - 32 M	13	jar	26.3									
80 - 33 M	2	jar	4.1									
80 - 33 M	3	jar	6.7									
80 - 33 M	4	jar	11.1									
80 - 33 M	5	jar	13.8									
80 - 33 M	6	jar	16.4									
80 - 33 M	7	jar	19.1									
80 - 33 M	10	jar	29.7									
80 - 34 M	2	jar	8.6									
80 - 34 M	3	jar	11.2									
80 - 34 M	4	jar	16.3									
80 - 34 M	5	jar	22.2									
80 - 34 M	6	jar	25.8									
82 - 42 M	1	jar	1.5									
82 - 42 M	2	jar	6.5									
82 - 42 M	4	jar	16.5									
82 - 42 M	7	jar	29.5									
82 - 42 M	8	jar	31.5									
82 - 42 M	9	jar	34.5									
82 - 42 M	10	jar	36.5									
82 - 42 M	11	jar	39.5	NP								
82 - 42 M	2	undist	10-11.4									
82 - 42 M	3	undist	15-16.3									
82 - 42 M	5	undist	25-26.4									
82 - 43 M	7	jar	31.5									
82 - 43 M	10	jar	41.5									
82 - 43 M	13	jar	56.5									
82 - 43 M	16	jar	71.5									
82 - 43 M	17	jar	76.5									
82 - 43 M	18	jar	81.5									
82 - 43 M	20	jar	91.5									
82 - 44 M	1	jar	1.5									
82 - 44 M	2	jar	7.0									
82 - 44 M	3	jar	9.0									
82 - 44 M	5	jar	11.5									
82 - 44 M	8	jar	31.5									
82 - 44 M	10	jar	41.5									
82 - 44 M	11	jar	46.5									
82 - 45 M	1	jar	1.5									
82 - 45 M	2	jar	4.0									
82 - 45 M	3	jar	6.0									
82 - 45 M	4	jar	9.5									
82 - 45 M	5	jar	11.5									
82 - 45 M	6	jar	15.5									
82 - 45 M	8	jar	25.5									
82 - 45 M	9	jar	31.5									
82 - 46 M	8	jar	36.5									
82 - 46 M	12	jar	51.0									
82 - 46 M	15	jar	66.5									
82 - 46 M	17	jar	76.5									
82 - 46 M	20	jar	80.6									
88 - 98 M	3	jar	8.8									
88 - 98 M	5	jar	15.7									
88 - 98 M	6	jar	20.8									
88 - 98 M	9	jar	36.7									
90 - 131 M	1	jar	1.0									
90 - 131 M	2	jar	3.7									
90 - 131 M	3	jar	4.6									
90 - 131 M	4	jar	6.8									
90 - 131 M	5	jar	12.0									
90 - 131 M	6	jar	16.5									
90 - 131 M	8	jar	21.7									
90 - 132 M	2	jar	3.5									
90 - 132 M	3	jar	5.5									
90 - 132 M	4	jar	7.7									
90 - 132 M	5	jar	9.1									

Boring No.	Sample No.	Sample Type	Depth (ft)	Atterberg Limits	Moisture Content	Mechanical Analysis	Hydro-meter	Specific Gravity	Triaxial Shear		Unconfined Compression	Consolidation Load&Reb.
									Q	R bar		
90 - 132 M	13	jar	27.0									
90 - 132 M	1	undist	14-16									
90 - 132 M	2	undist	19-21									
90 - 133 M	1	jar	1.5									
90 - 133 M	2	jar	12.0									
90 - 133 M	3	jar	16.0									
90 - 133 M	5	jar	19.0									
90 - 133 M	11	jar	26.5									
90 - 133 M	12	jar	34.7									
90 - 133 M	13	jar	53.0									
90 - 133 M	1	undist	8-10									
90 - 133 M	2	undist	17-19									
90 - 133 M	3	undist	22-24									
90 - 134 M	1	jar	1.5									
90 - 134 M	3	jar	7.5									
90 - 134 M	4	jar	12.0									
90 - 134 M	6	jar	16.0									
90 - 134 M	7	jar	19.0									
90 - 134 M	8	jar	26.5									
90 - 134 M	10	jar	34.7									
90 - 134 M	16	jar	53.0									
90 - 134 M	1	undist	3-4.3									
90 - 134 M	2	undist	8-10									
90 - 134 M	3	undist	13-15									
90 - 135 M	2	jar	3.5									
90 - 135 M	3	jar	9.5									
90 - 135 M	4	jar	11.5									
90 - 135 M	5	jar	16.0									
90 - 135 M	6	jar	21.5									
90 - 135 M	8	jar	31.5									
90 - 136 M	1	jar	3.5									
90 - 136 M	2	jar	6.0									
90 - 136 M	3	jar	10.									
90 - 136 M	4	jar	14.0									
90 - 136 M	5	jar	18.0									
90 - 136 M	6	jar	22.0									
90 - 136 M	7	jar	26.8									
90 - 136 M	8	jar	29.5									
90 - 137 M	3	jar	6.0									
90 - 137 M	4	jar	10.									
90 - 137 M	6	jar	13.5									
90 - 137 M	7	jar	17.5									
90 - 137 M	8	jar	24.0									
90 - 138 M	2	jar	7.2									
90 - 138 M	3	jar	11.9									
90 - 138 M	6	jar	29.2									
90 - 138 M	9	jar	42.0									
90 - 138 M	11	jar	49.4									
90 - 138 M	13	jar	53.0									
90 - 139 M	2	jar	3.1									
90 - 139 M	3	jar	6.0									
90 - 139 M	7	jar	25.2									
90 - 139 M	9	jar	35.5									
90 - 139 M	1	undist	14-16									
90 - 139 M	2	undist	19-20.8									
90 - 139 M	3	undist	31-33									
90 - 139 M	4	undist	44-46									
90 - 139 M	5	undist	54-56									
90 - 140 M	1	jar	3.0									
90 - 140 M	2	jar	9.0									
90 - 140 M	3	jar	13.0									
90 - 140 M	4	jar	18.7									
90 - 140 M	5	jar	23.6									
90 - 140 M	8	jar	36.8									
90 - 140 M	11	jar	50.7									
90 - 140 M	12	jar	55.2									
90 - 141 M	2	jar	4.8									
90 - 141 M	4	jar	9.2									
90 - 141 M	6	jar	19.0									
90 - 141 M	8	jar	27.8									
90 - 141 M	11	jar	41.6									
90 - 143 M	3	jar	7.0									
90 - 143 M	4	jar	10.9									
90 - 143 M	7	jar	26.8									
90 - 143 M	9	jar	35.7									
90 - 143 M	1	undist	4-5									
90 - 143 M	2	undist	12-14									
90 - 143 M	3	undist	20-22									
91 - 144 M	4	undist	14.5-17.2									

Boring No.	Sample No.	Sample Type	Depth (ft)	Atterberg Limits	Moisture Content	Mechanical Analysis	Hydro-meter	Specific Gravity	Triaxial Shear		Unconfined Compression	Consolidation Load&Reb.
									Q	R bar		
91 - 144 M	2	jar	8.9									
91 - 144 M	7	jar	23.0									
91 - 144 M	8	jar	30.0									
91 - 144 M	11	jar	45.0									
91 - 146 M	3	jar	8.5									
91 - 146 M	4	jar	10.5									
91 - 146 M	7	jar	21.5									
91 - 147 M	4	jar	20.0									
91 - 148 A	1	undist	8-12									
91 - 148 A	1	remold	8-12									
92 - 167 M	4	jar	19.5									
92 - 168 M	6	jar	20.0									
92 - 169 M	1	jar	4.5									
92 - 169 M	3	jar	9.0									
92 - 169 M	6	jar	18.9									
92 - 169 M	9	jar	25.0									
92 - 169 M	10	jar	30.0									
92 - 169 M	11	jar	35.0									
92 - 169 M	1	undist	12.5-14.5									
92 - 170 M	2	jar	5.0									
92 - 170 M	3	jar	9.0									
92 - 170 M	4	jar	13.0									
92 - 170 M	5	jar	20.0									
92 - 170 M	6	jar	22.8									
92 - 170 M	7	jar	24.6									
92 - 170 M	8	jar	26.5									
92 - 171 M	1	jar	2.0									
92 - 171 M	2	jar	5.0									
92 - 171 M	4	jar	15.0									
92 - 171 M	6	jar	18.0									
92 - 171 M	8	jar	20.0									
92 - 171 M	9	jar	22.7									
92 - 171 M	1	undist	24-26									
92 - 171 M	2	undist	30-32									
92 - 171 M	3	undist	34-36									
92 - 172 M	4	jar	20.0									
92 - 172 M	1	undist	29-31									
92 - 173 M	2	jar	10.0									
92 - 173 M	10	jar	44.4									
92 - 173 M	1	undist	23-25									
92 - 173 M	3	undist	40-42									
92 - 174 M	1	jar	3.0									
92 - 174 M	2	jar	8.0									
92 - 174 M	3	jar	10.0									
92 - 174 M	8	jar	35.0									
92 - 174 M	9	jar	40.0									
92 - 195 M	6	jar	27.5									
92 - 195 M	7	jar	29.5									
92 - 195 M	8	jar	32.5									
92 - 195 M	10	jar	44.5									
92 - 195 M	1	undist	2-4									
92 - 195 M	2	undist	11-13									
92 - 195 M	3	undist	15-17									
92 - 195 M	4	undist	23-25									
92 - 195 M	5	undist	36-38									
92 - 195 M	6	undist	38-40									
92 - 196 M	1	jar	9.0									
92 - 196 M	3	jar	19.5									
92 - 196 M	5	jar	29.5									
92 - 196 M	6	jar	34.5									
92 - 196 M	9	jar	49.5									
92 - 197 M	1	jar	2.5									
92 - 197 M	3	jar	8.4									
92 - 197 M	4	jar	12.0									
92 - 197 M	1	undist	4-4.6									
92 - 198 M	2	jar	9.0									
92 - 198 M	4	jar	19.5									
92 - 198 M	6	jar	27.0									
92 - 198 M	1	undist	3-4.2									
92 - 199 M	1	jar	10.0									
92 - 199 M	2	jar	4.0									
92 - 199 M	3	jar	8.5									
92 - 199 M	4	jar	11.5									
92 - 199 M	5	jar	15.0									
92 - 199 M	6	jar	17.0									
92 - 199 M	7	jar	19.5									
92 - 199 M	8	jar	21.5									
92 - 200 M	4	jar	10.0									
92 - 200 M	5	jar	12.0									

Boring No.	Sample No.	Sample Type	Depth (ft)	Atterberg Limits	Moisture Content	Mechanical Analysis	Hydro-meter	Specific Gravity	Triaxial Shear Q	Triaxial Shear R bar	Unconfined Compression	Consolidation Load&Reb.
92 - 200 M	6	jar	14.5									
92 - 200 M	9	jar	24.5									
92 - 200 M	10	jar	29.0									
92 - 200 M	12	jar	39.5									
92 - 200 M	1-1	undist	3-5									
92 - 200 M	1-2	undist	20-22									
92 - 200 M	2-2	undist	20.5-21.7									
92 - 200 M	2-3	undist	34-36									
92 - 201 M	1	jar	1.5									
92 - 201 M	2	jar	3.8									
92 - 201 M	3	jar	8.6									
92 - 201 M	4	jar	9.5									
92 - 201 M	5	jar	11.0									
92 - 201 M	6	jar	14.0									
92 - 201 M	7	jar	15.0									
92 - 201 M	9	jar	24.2									
92 - 202 M	1	jar	9.0									
92 - 202 M	2	jar	3.0									
92 - 202 M	4	jar	13.0									
92 - 203 M	1	jar	10.0									
92 - 203 M	2	jar	5.0									

NOTE: TESTING OF SAMPLE 92-200M 2-2 WAS CONDUCTED BY SOIL ENGINEERING TESTING, INC.

SOIL CLASSIFICATION RECORD SHEET

Project: Chaska Minnesota - Flood Control Project			Boring No: 80-29M through 80-31M	MRD Lab. No: 80/227
Station: -	Range: -	Surf. Elev: -	Depth To Water Table: -	Bottom Of Hole: -

Sample No.	Depth To Bottom Of Sample	Moisture (%)	Plasticity (Att. Limits) L.L.	Plasticity (Att. Limits) P.I.	Grading (Cumulative Percents Finer) Hyd. Analsis Fines .005	Fines .02mm	U. S. Standard Sieve Sizes Fines 200	Sand 80	Sand 40	Sand 20	Sand 10	Sand 4	Gravel 3/8	Gravel 3/4	Gravel 1 1/2	Gravel 3 in	Gradation Curve Analysis D_{60} (mm)	D_{30} (mm)	D_{10} (mm)	C_u	C_c	Classification Tech. MEMO 3-357, May 67	Remarks PL
Hole	80-29M																						
2	2.1						No sample recieved																
4	10.9						34	46	65	76	87	95	98	100									
6	16.2						6	9	18	29	42	56	66	79	100		5.8	0.92	0.18	32.2	0.81		
8	20.4	22.4	23	7																			16
9	23.9	30.3	56	39																			17
10	28.6	23.8																					
11	29.5	25.3																					
Hole	80-30M																						
3	9.2						27	51	92	100													
4	15.0						7	14	23	27	34	44	51	83	100		14.0	1.20	0.11	127.3	0.94		
6	21.2						8	12	32	51	63	68	78	90	100		1.8	0.40	0.13	13.8	0.68		
8	31.5						5	7	15	21	30	46	61	79	100		9.0	1.9	0.24	27.5	1.7		
10	41.4						8	10	16	28	49	72	91	100			3.2	0.90	0.16	20.0	1.6		
Hole	80-31M																						
2	1.9						9	21	52	74	88	96	100				0.52	0.24	0.082	6.3	1.4		
3	9.3	17.4	31	17																			14
6	14.2	25.0	26	11																			15
Hole	80-32M																						
1	1.5						46	60	72	82	91	97	99	100									
3	6.6	33.0																					
5	11.0	28.2	41	27																			14
6	13.9	25.9																					
7	16.1	36.0	55	39																			16
8	19.4	32.3	39	24																			15
10	21.8	28.2																					
11	23.1	39.5																					
13	26.3						35	83	100														

Table - 3

MRD FORM NOV. 75 16 EDITION OF MAY 70 IS OBSOLETE

FIGURE D-1

SOIL CLASSIFICATION RECORD SHEET

Project: Chaska Minnesota - Flood Control Project | **Boring No:** 80-33M and 80-34M | **MRD Lab. No:** 80/227

Station: - | **Range:** - | **Surf. Elev:** - | **Depth To Water Table:** - | **Bottom Of Hole:** -

Sample No.	Depth To Bottom Of Sample	Moisture (%)	Plasticity (Att. Limits) L.L.	Plasticity (Att. Limits) P.I.	Grading (Cumulative Percents Finer) Hyd. Analsis Fines .005	.02mm	U. S. Standard Sieve Sizes 200	Sand 80	40	20	10	4	Gravel 3/8	3/4	1 1/2	3 in	Gradation Curve Analysis D_{60} (mm)	D_{30} (mm)	D_{10} (mm)	C_u	C_c	Classification Tech. MEMO 3-357, May 67	Remarks PL
Hole	80-33M																						
2	4.1						35	59	80	87	92	96	100										
3	6.7	22.3	28	13																			15
4	11.1	26.0																					
5	13.8						8	19	40	70	96	100					0.65	0.30	0.088	7.4	1.6		
6	16.4	35.9	47	32																			15
7	19.1						2	4	22	55	83	93	97	100			0.98	0.47	0.23	4.3	0.98		
10	29.7						5	10	33	64	88	98	100				0.80	0.39	0.17	4.7	1.1		
Hole	80-34M																						
2	3.6	165.0	163	64			53	70	83	95	100												99
3	11.2	134.5																					
4	16.3	176.4	181	76																			105
5	22.2	164.0	199	91																			108
6	25.8						2	10	73	99	100						0.40	0.27	0.17	2.4	1.1		

MRD FORM NOV. 75 16 ED[illegible]N OF MAY 70 IS OBSOLETE

Table - 4

FIGURE D-2

SOIL CLASSIFICATION RECORD SHEET

Project: Chaska Flood Control			Boring No: 82-39M through 82-42M	MRD Lab. No: 83/67
Station: -	Range: -	Surf. Elev: -	Depth To Water Table: -	Bottom Of Hole: -

Sample No.	Depth To Bottom Of Sample	Moisture (%)	Plasticity (Att. Limits) L.L.	Plasticity (Att. Limits) P.I.	Grading (Cumulative Percents Finer) Hyd. Analsis Fines .005	.02mm	U.S. Standard Sieve Sizes 200	Sand 80	40	20	10	4	Gravel 3/8	3/4	1 1/2	3 in	Gradation Curve Analysis D_{60} (mm)	D_{30} (mm)	D_{10} (mm)	C_u	C_c	Classification Tech. MEMO 3-357, May 67	Remarks	PL
Hole	82-39M																							
2	6.5	25.4					26	79	99	100														
3	11.5	53.3					62	93	99	100														
4	14.5	18.9					8	16	47	79	96	99	100				0.53	0.25	0.087	6.1	1.4			
6	21.5						2	4	9	16	39	82	100				3.6	1.5	0.50	7.2	1.3			
7	26.5						13	26	57	76	89	95	100											
Hole	82-40M																							
2	6.2	34.0	35	15			83	94	98	100												Loss on Ignition 3.4%		20
3	11.0	29.2					13	35	74	92	99	100												
4	16.5						6	10	21	31	39	51	60	71	100		9.7	0.78	0.18	53.9	0.35			
6	26.5	21.0					89	100																
7	31.5	22.5	34	18																				16
8	36.5	24.3	49	29																				20
Hole	82-41M																							
1	1.5	35.9	36	19																				17
2	6.5																					Loss on Ignition 8.3%		
3	11.5																					Loss on Ignition 6.6%		
4	16.5	50.3	70	47																		Loss on Ignition 5.5%		23
7	27.0	25.2	24	4																				20
8	31.5	25.5	42	23																				19
Hole	82-42M																							
1	1.5	34.8	48	27																		Loss on Ignition 4.9%		21
2	6.5	106.6	122	69																		Loss on Ignition 18.2%	Peat	53
3	11.5																					Loss on Ignition 13.8%		
4	16.5	298.6	335	163																		Loss on Ignition 43.2%	Peat	172
6	26.4																					Peat, Limestone, Sand m	x	
7	29.5	32.1	31	14																				17
8	31.5	69.6	92	51																		Loss on Ignition 12.9%		41
9	34.5	40.3	42	21																				21
10	36.5	32.6	36	19																				17
11	39.5	72.1	NP	NP																		Shells, limestone, sand	mix	

MRD FORM NOV 75 16 EDITION OF MAY 70 IS OBSOLETE

Table - 1

FIGURE D-3

SOIL CLASSIFICATION RECORD SHEET

Project: Chaska Flood Control		Boring No: 82-43M through 82-46M	MRD Lab. No: 83/67
Station: -	Range: -	Surf. Elev: -	Depth To Water Table: -
			Bottom Of Hole: -

Sample No.	Depth To Bottom Of Sample	Moisture (%)	Plasticity (Att. Limits) L.L.	P.I.	Grading (Cumulative Percents Finer) Hyd. Analysis Fines .005	.02mm	U.S. Standard Sieve Sizes 200	Sand 80	40	20	10	4	Gravel 3/8	3/4	1 1/2	3 in	Gradation Curve Analysis D_{60} (mm)	D_{30} (mm)	D_{10} (mm)	C_u	C_c	Classification Tech. MEMO 3-357, May 67	Remarks PL
Hole	82-43M																						
7	31.5						4	6	12	16	25	41	52	64	100		16.5	2.6	0.30	55.0	1.4		
10	41.5						10	12	15	17	24	40	60	83	100		9.0	2.6	0.050	180.0	15.0		
13	56.5						10	35	89	100							0.26	0.15	0.079	3.3	1.1		
16	71.5						7	28	83	94	98	100					0.30	0.18	0.085	3.5	1.3		
17	76.5						6	44	80	93	100						0.25	0.13	0.081	3.1	0.83		
18	81.5						8	15	36	75	97	100					0.65	0.32	0.11	5.9	1.4		
20	91.5						6	12	45	66	77	86	94	97	100		0.58	0.30	0.15	3.9	1.0		
Hole	82-44M																						
1	1.5						10	13	55	95	99	100					0.44	0.24	0.11	4.0	1.2		
2	7.0	104.0	164	81																			
3	9.0						40	54	89	100													Peat 83
5	11.5						12	16	60	97	98	99	100				0.40	0.24	0.015	26.7	9.6		
8	31.5						5	9	60	93	98	100					0.40	0.28	0.18	2.2	1.0		
10	41.5						8	14	49	81	93	97	99	100			0.48	0.25	0.10	4.8	1.3		
11	46.5						7	14	56	90	97	100					0.43	0.25	0.11	3.9	1.3		
Hole	82-45M																						
1	1.5	27.3																					
2	4.0	23.6					41	71	92	97	100												
3	6.5	102.7	99	50																			
4	9.5						14	18	31	43	57	68	83	97	100								Peat 49
5	11.5						12	20	33	41	55	73	84	88	100		3.7	0.38	0.058	63.8	0.67		
6	15.5	25.8	27	11			70	90	97	99	100												
8	25.5	27.3	25	10			41	60	79	87	93	99	100										26
9	31.5	28.9	32	10			73	94	97	99	100												15
																							22
Hole	82-46M																						
8	36.5						7	8	12	20	37	57	73	84	100		4.8	1.4	0.25	19.2	1.6		
12	51.0						11	13	17	29	94	98	99	100			1.4	0.88	0.06	23.3	9.2		
15	66.5						8	12	31	62	80	94	98	100			0.80	0.40	0.12	6.7	1.7		
17	76.5						5	8	40	88	98	100					0.59	0.36	0.17	3.5	1.3		
20	80.6						5	12	84	99	100						0.32	0.25	0.14	2.3	1.4		

MRD FORM 16 NOV. 75 ED[illegible] OF MAY 70 IS OBSOLETE

Table - 2

FIGURE D-4

SOIL CLASSIFICATION RECORD SHEET

PROJECT: Chaska Flood Control Project - East Creek																BORING: 88-94M through 88-99M							MRD LAB NO. 88/1391		
STATION:			RANGE:				SURF.ELEV.:									DEPTH TO WATER TABLE:							BOTTOM OF HOLE:		
					GRADING (CUMULATIVE PERCENTS FINER)																				
	DEPTH TO	MOIST-	PLASTICITY		HYD. ANALYSIS		U.S. STANDARD SIEVE SIZE										GRADATION CURVE ANALYSIS					CLASSIFICATION			
SAMP	BOTTOM	URE	(ATT. LIMITS)		FINES		SANDS						GRAVEL				D60	D30	D10						
NO.	OF SAMP	(%)	LL	PI	.005	.02mm	200	80	40	20	10	4	3/8	3/4	1-1/2	3 IN	(mm)	(mm)	(mm)	Cu	Cc	TECH MEMO 3-357, MAY 67	REMARKS	PL	
Hole	88-94M																								
1	0.9						53	76	94	98	99	100													
6	13.9						33	45	61	77	92	100													
Hole	88-95M																								
11	22.6	19.7	39	25			83	99	100															14	
Hole	88-96M																								
2	3.8						9	28	60	78	89	95	98	100			0.40	0.20	0.09	4.4	1.1				
4	11.0																								
6	15.7						73	90	97	99	100												Loss on Ignition 44.1%		
Hole	88-97M																								
2	1.7						28	50	81	95	99	100													
4	10.8						2	10	54	77	85	91	95	98	100		0.50	0.30	0.18	2.8	1.0				
6	21.4						11	19	43	58	70	79	98	95	100		0.99	0.27	0.05	19.2	1.5				
Hole	88-98M																								
3	8.8						5	16	64	86	94	97	99	100			0.42	0.30	0.12	3.5	1.8				
5	15.7						13	25	49	54	57	60	66	79	100										
6	20.8	10.5	22	12																				10	
9	36.7	9.0	16	3																				13	
Hole	99-99M																								
3	8.6						10	22	50	63	70	78	94	100			0.70	0.20	0.08	8.8	0.7				
4	12.1						26	38	86	98	100														
5	15.7						9	42	99	100							0.25	0.10	0.08	3.3	0.5				
9	29.0						5	9	22	45	70	80	87	93	100		1.40	0.67	0.22	6.4	1.5				

TABLE 2

SOIL CLASSIFICATION RECORD SHEET

PROJECT: Chaska, East Creek	BORING: 90-131M through 90-136M	MRD LAB NO. 90/358
STATION: RANGE: SURF.ELEV.:	DEPTH TO WATER TABLE:	DATE: 7 August 1990

SAMP NO.	DEPTH TO BOTTOM OF SAMP	MOISTURE (%)	PLASTICITY (ATT. LIMITS) LL	PI	GRADING (CUMULATIVE PERCENTS FINER) HYD. ANALYSIS FINES .005	.02mm	U.S. STANDARD SIEVE SIZE 200	SAND 80	40	20	10	4	GRAVEL 3/8	3/4	1-1/2	3 IN	GRADATION CURVE ANALYSIS D60 (mm)	D30 (mm)	D10 (mm)	Cu	Cc	CLASSIFICATION TECH MEMO 3-357, MAY 67		REMARKS	PL
Hole	90-131M																								
1	1.0	23.7	60	35																		Fat clay	CH		25
2	3.7						19	29	80	96	99	100										Silty sand	SM		
3	4.6						6	9	19	30	43	59	79	100			4.76	0.84	0.19	25.41	0.79	Silty grav. sand	SM-SP		
4	6.8						8	11	34	77	85	89	94	100			0.63	0.38	0.16	4.03	1.49	Silty sand	SM-SP		
5	12.0						13	16	26	44	65	85	92	100								Silty gravelly sand	SM		
8	21.7						6	17	82	98	100						0.31	0.21	0.14	2.31	1.09	Silty sand	SM-SP		
Hole	90-132M																								
2	5.5 3.5						67	82	92	95	98	100										Sandy clay	CL		
3	7.7						4	15	59	82	92	98	100				0.42	0.24	0.14	3.07	1.03	Sand	SP		
4	9.1	32.6	60	36																		Fat clay	CH		24
5		14.2	31	16																		Lean clay	CL		15
13	27.0						3	5	20	25	28	33	44	55	100		20.85	3.30	0.24	86.10	2.16	Sandy gravel	GM		
Hole	90-133M																								
1	1.5	12.3	45	23																		Lean clay	CL		22
2	4.0						28	55	84	95	100											Silty sand	SM		
3	5.4						15	36	69	85	94	98	100									Silty sand	SM		
5	11.7						11	15	28	38	47	55	65	82	100		6.92	0.48	0.05	138.36	0.66	Silty grav. sand	SM-SP		
11	29.9						23	45	71	88	96	100										Silty sand	SM		
12	33.5						25	48	74	84	93	99	100									Silty sand	SM		
13	37.1	33.7	31	10																		Lean clay	CL		21
Hole	90-134M																								
1	1.5						63	80	91	96	99	100										Sandy clay	CL		
4	12.0	26.1	39	24																		Lean clay	CL		15
6	16.0						12	27	46	55	61	66	74	85	100		1.80	0.20	0.06	29.98	0.37	Silty grav. sand	SM-SP		
7	19.0						4	8	49	69	74	77	84	100			0.58	0.29	0.19	3.14	0.77	Gravelly sand	SP		
8	26.5						32	55	84	91	96	100										Silty sand	SM		
10	34.7	44.9	33	15																		Lean clay	CL		18
16	53.0						4	5	24	48	77	93	97	100			1.17	0.51	0.24	4.93	0.93	Sand	SP		
Hole	90-135M																								
2	2.0	3.5					8	13	27	35	40	45	54	64	100		15.85	0.54	0.11	138.03	0.16	Silty grav. sand	SM-SP		
4	4.0	11.5					4	5	14	52	71	83	92	100			1.09	0.57	0.35	3.09	0.83	Gravelly sand	SP		
6	6.0	21.5					6	8	52	88	96	99	100				0.48	0.29	0.18	2.61	0.92	Silty sand	SM-SP		
8	8.0	31.5					2	4	47	92	97	99	100				0.51	0.32	0.21	2.40	0.95	Sand	SP		
Hole	90-136M																								
1	3.5						10	25	75	95	99	100					0.32	0.20	0.08	4.31	1.58	Silty sand	SM-SP		
2	6.0						6	8	50	89	99	100					0.49	0.29	0.19	2.59	0.93	Silty sand	SM-SP		
3	10.0						4	5	51	99	100						0.47	0.30	0.20	2.32	0.95	Sand	SP		
5	18.0						2	3	61	100							0.42	0.28	0.20	2.06	0.91	Sand	SP		
6	22.0						6	8	25	38	42	49	61	74	100		9.02	0.53	0.20	45.71	0.16	Silty grav. sand	SM-SP		
7	26.8						92	99	99	100												Lean clay	CL		
8	29.5						10	52	89	99	100						0.21	0.11	0.07	2.96	0.85	Silty sand	SM-SP		

TABLE 1

FIGURE D-6

SOIL CLASSIFICATION RECORD SHEET

PROJECT: Chaska, East Creek	BORING: 90-137M through 90-143M		NRD LAB NO. 90/358
STATION: RANGE:	SURF.ELEV.:	DEPTH TO WATER TABLE:	DATE: 7 August 1990

SAMP NO.	DEPTH TO BOTTOM OF SAMP	MOISTURE (%)	PLASTICITY (ATT. LIMITS) LL	PI	GRADING (CUMULATIVE PERCENTS FINER) HYD. ANALYSIS FINES .005	.02mm	U.S. STANDARD SIEVE SIZE 200	SAND 80	40	20	10	4	GRAVEL 3/8	3/4	1-1/2	3 IN	GRADATION CURVE ANALYSIS D60 (mm)	D30 (mm)	D10 (mm)	Cu	Cc	CLASSIFICATION TECH MEMO 3-357, MAY 67	REMARKS	PL
Hole	90-137M																							
3	6.0						3	4	50	100							0.48	0.31	0.21	2.30	0.95	Sand SP		
6	13.5						6	34	93	99	100						0.25	0.16	0.09	2.92	1.16	Silty sand SM-SP		
8	24.0						4	23	57	85	95	99	100				0.42	0.22	0.10	4.12	1.08	Sand SP		
Hole	90-138M																							
2	7.2						6	8	17	33	43	53	72	93	100		6.31	0.73	0.23	27.32	0.37	Silty grav. sand SM-SP		
6	29.2						5	7	15	28	43	58	73	89	100		5.31	0.92	0.27	19.50	0.59	Silty grav. sand SM-SP		
9	42.0						5	7	10	15	31	55	75	86	100		5.69	1.88	0.45	12.74	1.40	Silty grav. sand SM-SW		
11	49.4						60	79	96	100												Sandy clay CL		
13	53.0						8	51	99	100							0.21	0.12	0.08	2.56	0.83	Silty sand SM-SP		
Hole	90-139M																							
2	3.1	19.2	35	17																		Lean clay CL		18
3	6.0	27.8	46	28																		Lean clay CL		18
7	25.2						10	21	50	63	74	86	96	100			0.71	0.23	0.08	9.34	1.02	Silty sand SM-SW		
9	35.5	21.9	44	26																		Lean clay CL		18
Hole	90-140M																							
1	3.0						6	9	16	36	61	82	93	100			1.90	0.70	0.24	7.88	1.06	Silty grav. sand SM-SW		
4	18.7						3	4	10	28	48	67	78	82	100		3.43	0.89	0.42	8.16	0.55	Gravelly sand SP		
8	36.8						2	3	41	98	100						0.52	0.35	0.22	2.32	1.03	Sand SP		
11	50.7						5	8	20	31	42	54	63	72	100		7.33	0.78	0.22	33.49	0.38	Silty grav. sand SM-SP		
12	55.2						8	30	81	97	100						0.29	0.18	0.08	3.51	1.30	Silty sand SM-SP		
Hole	90-141M																							
2	4.8						5	14	93	100							0.29	0.21	0.16	1.86	1.01	Silty sand SM-SP		
4	9.2						3	14	81	98	99	100					0.32	0.22	0.15	2.10	1.00	Sand SP		
8	27.8						4	11	65	91	97	100					0.39	0.24	0.17	2.30	0.93	Sand SP		
11	41.6						5	14	75	97	100						0.34	0.23	0.15	2.24	1.00	Silty sand SM-SP		
Hole	90-143M																							
3	7.0						51	66	81	91	98	100										Sandy clay CL		
4	10.9						51	65	80	92	99	100										Sandy clay CL		
7	26.8						42	89	99	100												Silty sand SM		
9	35.7						6	16	51	90	99	99	100				0.49	0.27	0.12	3.98	1.17	Silty sand SM-SP		

TABLE 2

FIGURE D-7

SOIL CLASSIFICATION RECORD SHEET

PROJECT: Chaska Flood Control, Stage 3, East Creek	BORING: 90-131, 135, 136, 137, 138, 140, 141, 91-144, 146, & 147	NRD LAB NO. 839
STATION: RANGE: SURF.ELEV.:	DEPTH TO WATER TABLE:	DATE: 22 March 1991

SAMP NO.	DEPTH TO BOTTOM OF SAMP	MOISTURE (%)	PLASTICITY (ATT. LIMITS) LL	PI	GRADING (CUMULATIVE PERCENTS FINER) HYD. ANALYSIS FINES .005	.02mm	U.S. STANDARD SIEVE SIZE 200	SAND 80	40	20	10	4	GRAVEL 3/8	3/4	1-1/2	3 IN	GRADATION CURVE ANALYSIS D60 (mm)	D30 (mm)	D10 (mm)	Cu	Cc	CLASSIFICATION TECH MEMO 3-357, MAY 67	REMARKS	PL
Hole	90-131																							
6	16.5						7	10	19	51	63	69	77	83	100		1.55	0.54	0.17	9.37	1.12	Silty grav. sand SM-SW		
Hole	90-135																							
3	9.5						7	9	16	38	58	73	89	93	100		2.32	0.66	0.28	8.32	0.68	Silty grav. sand SM-SP		
5	16.0						3	4	16	56	72	85	92	100			0.93	0.54	0.35	2.66	0.89	Silty gravelly sand SP		
Hole	90-136																							
4	14.0						3	4	55	100							0.45	0.27	0.19	2.31	0.85	Sand SP		
Hole	90-137																							
4	10.0						2	3	73	100							0.36	0.25	0.19	1.86	0.88	Sand SP		
7	17.5						8	41	96	100							0.25	0.15	0.08	3.15	1.03	Silty sand SM-SP		
Hole	90-138																							
3	11.9						3	5	13	31	49	67	79	95	100		3.35	0.80	0.35	9.57	0.55	Silty gravelly sand SP		
Hole	90-140																							
2	9.0						3	5	11	28	51	71	84	90	100		2.95	0.89	0.40	7.41	0.68	Silty gravelly sand SP		
3	13.0						2	3	10	37	62	83	92	95	100		1.86	0.70	0.40	4.62	0.65	Silty gravelly sand SP		
5	23.6						3	4	12	33	48	60	73	89	100		4.84	0.76	0.38	12.75	0.31	Silty gravelly sand SP		
Hole	90-141																							
6	19.0						3	6	36	76	93	98	100				0.61	0.35	0.20	3.08	1.03	Sand SP		
Hole	91-144																							
2	8.9	20.7	32	19																		Lean clay CL		13
7	23.0						3	18	96	100							0.28	0.20	0.11	2.57	1.32	Sand SP		
8	30.0						8	11	23	38	54	70	83	95	100		2.75	0.59	0.15	18.68	0.85	Silty grav. sand SM-SP		
11	45.0						4	5	14	42	60	79	90	100			1.95	0.62	0.36	5.46	0.56	Silty gravelly sand SP		
Hole	91-146																							
3	8.5	10.2	23	11																		Lean clay CL		12
4	10.5	28.5	47	29																		Lean clay CL		18
7	21.5	15.5	33	20																		Lean clay CL		13
Hole	91-147																							
4	20.0						3	11	48	83	91	92	94	96	100		0.54	0.29	0.17	3.21	0.96	Sand SP		

TABLE 1

FIGURE D-8

SOIL CLASSIFICATION RECORD SHEET

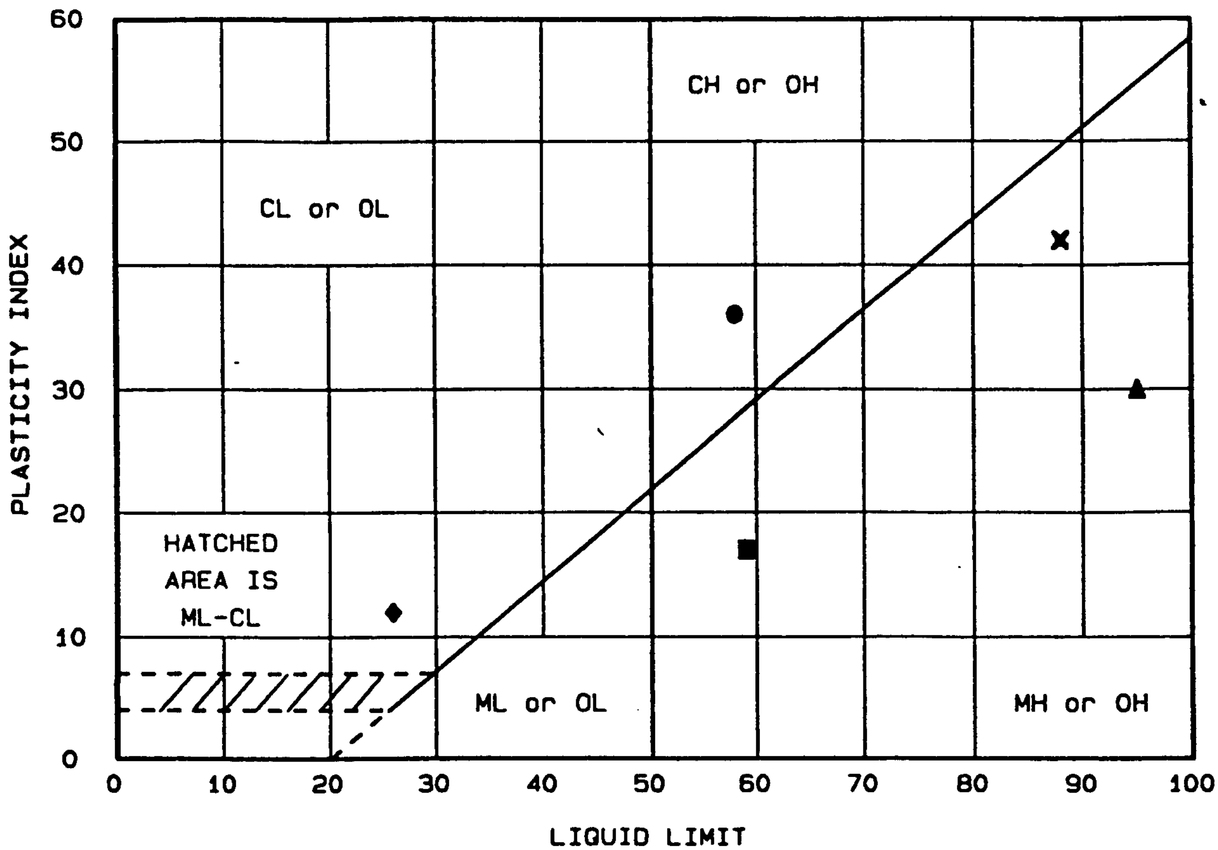
PROJECT: Chaska Flood Control | BORINGS: 90-134M through 92-174M | MRD LAB NO. 1535

STATION: | RANGE: | SURF.ELEV.: | DEPTH TO WATER TABLE: | DATE: 28 July 1992

SAMP NO.	DEPTH TO BOTTOM OF SAMP	MOISTURE (%)	PLASTICITY (ATT. LIMITS) LL	PI	GRADING (CUMULATIVE PERCENTS FINER) HYD. ANALYSIS FINES .005	.02mm	U.S. STANDARD SIEVE SIZE SANDS 200	80	40	20	10	4	GRAVEL 3/8	3/4	1-1/2	3 IN	GRADATION CURVE ANALYSIS D60 (mm)	D30 (mm)	D10 (mm)	Cu	Cc	Dried in 110 Oven?	CLASSIFICATION TECH MEMO 3-357, MAY 67	REMARKS	PL
Hole	90-134M																								
D-3	7.5		58	36			72	82	91	96	97	99	100									y	Sandy Clay CH		22
Hole	92-167M																								
D-4	19.5	164.4	95	30			59	75	94	99	100											y	Sandy Silt MH		65
Hole	92-168M																								
D-6	20.0	71.2	59	17			44	59	77	91	98	100										y	Silty Sand SM		42
Hole	92-169M																								
D-1	4.5	22.4	26	12			39	60	82	92	98	99	100									y	Clayey Sand SC		14
D-3	9.0						17	26	60	91	100												Silty Sand SM		
D-6	18.9						11	21	45	65	82	93	99	100			0.68	0.25	0.07	10.06	1.39		Silty Sand SW-SM		
D-9	25.0	32.1	26	7			64	84	95	99	100												Sandy Silty Clay CL-ML		19
D-10	30.0						10	22	52	67	78	87	93	100			0.57	0.23	0.08	7.25	1.17		Silty Sand SW-SM		
D-11	35.0	29.3	29	9																			Lean Clay CL		20
Hole	92-170M																								
D-2	5.0						9	19	44	62	75	85	96	100			0.78	0.27	0.09	8.52	1.05		Silty Gravelly Sand SW-SM		
D-3	9.0	69.1	88	42																		y	Organic Silt OH		46
D-4	13.0	75.6	90	53																		y	Organic Clay OH		37
D-5	20.0	25.7	23	7			35	50	75	88	96	100											Clayey Sand SC-SM		16
D-6	22.8		N.A.	N.A.			60	82	95	99	100												Sandy Silt ML		
D-7	24.6						14	24	40	52	67	85	96	100									Silty Gravelly Sand SM		
D-8	26.5		43	23																			Lean Clay CL		20
Hole	92-171M																								
D-1	2.0						12	17	29	43	59	72	85	92	100		2.09	0.44	0.04	52.23	2.33		Silty Gravelly Sand SW-SM		
D-2	5.0						26	38	55	66	75	83	90	100									Silty Gravelly Sand SM		
D-4	15.0	18.3	26	11			33	47	66	79	88	95	97	100									Clayey Sand SC		15
D-6	18.0						38	53	75	87	95	99	100										Silty Sand SM		
D-8	20.0	26.1	55	36																			Fat Clay CH		19
D-9	22.7	21.5	30	12			32	46	71	85	94	98	100										Clayey Sand SC		18
Hole	92-172M																								
D-4	20.0	113.0	72	20			99	99	100														Silt MH		52
Hole	92-173M																								
D-2	10.0	91.6	76	22																			Silt MH		54
D-10	44.4	27.1	49	24																			Lean Clay CL		25
Hole	92-174M																								
D-1	3.0						22	30	43	55	71	83	91	100									Silty Gravelly Sand SM		
D-2	8.0						23	31	44	56	70	84	91	100									Silty Gravelly Sand SM		
D-3	10.0	105.9	117	57																		y	Organic Silt OH		60
D-8	35.0						5	8	36	81	96	100					0.59	0.35	0.19	3.11	1.10		Silty Sand SP-SM		
D-9	40.0						6	14	56	87	93	95	95	100			0.46	0.25	0.12	3.79	1.11		Silty Sand SP-SM		

TABLE 1.

LIQUID AND PLASTIC LIMITS TEST REPORT



	Location + Description	LL	PL	PI	-200	ASTM D 2487-85
●	90-134M D-3 7'- 7.5'	58	22	36	71.6	CH, Fat clay with sand
▲	92-167M D-4 18.5'- 19.5'	95	65	30	58.8	MH, Sandy elastic silt
■	92-168M D-6 17'- 20'	59	42	17	44.4	SM, Silty sand
◆	92-169M D-1 3'- 4.5'	26	14	12	38.9	SC, Clayey sand
✖	92-170M D-3 6.5'- 9	88	46	42		OH, Organic silt

Project No.: 1535
Project: CHASKA FLOOD CONTROL

Client: ST. PAUL DISTRICT
Location: MINNESOTA

Date: 7-28-92

Remarks:

LIQUID AND PLASTIC LIMITS TEST REPORT

COE - MISSOURI RIVER DIV. LAB

Fig. No. 1

LIQUID & PLASTIC LIMIT TEST DATA

PROJECT DATA

Project No.: 1535 Date: 7-28-92
Client: ST. PAUL DISTRICT
Project: CHASKA FLOOD CONTROL

Project location: MINNESOTA

Remarks:

Figure Number: 2

TEST DATA - Test number 1

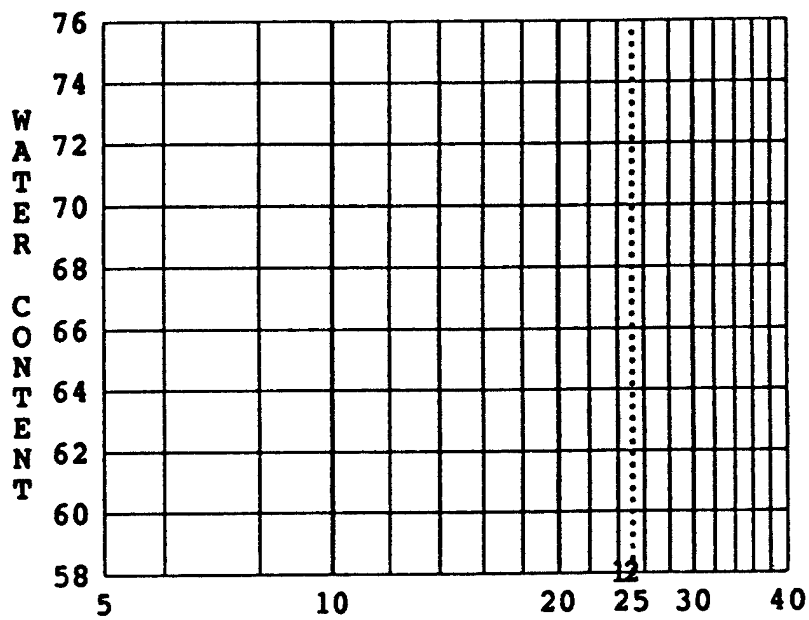
Location and description: 90-134M
D-3 7'- 7.5'

LIQUID LIMITS

Run No.	1	2	3	4
WT w+t	4.475	4.66		
WT dry	3.417	3.536		
WT tare	1.594	1.597		
# Blows	24	25		
Moisture	58.0	58.0		

PLASTIC LIMITS

Run No.	1	2	3
WT w+t	3.478	3.126	
WT dry	3.137	2.851	
WT tare	1.597	1.594	
Moisture	22.1	21.9	



Liquid Limit = 58
Plastic Limit = 22
Plasticity Index = 36

CLASSIFICATION DATA

%-4 = 99.2 %-10 = 98.6 %-40 = 91.4 %-200 = 71.6
Uniformity Coefficient = Curvature Coefficient =
LL = 58 PL = 22 PI = 36 LL (oven dry) = 51
ASTM = CH, Fat clay with sand
AASHTO = A-7-6(26)

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FIGURE D-11

LIQUID & PLASTIC LIMIT TEST DATA

PROJECT DATA

Project No.: 1535 Date: 7-28-92
Client: ST. PAUL DISTRICT
Project: CHASKA FLOOD CONTROL

Project location: MINNESOTA

Remarks:

Figure Number: 3

TEST DATA - Test number 2

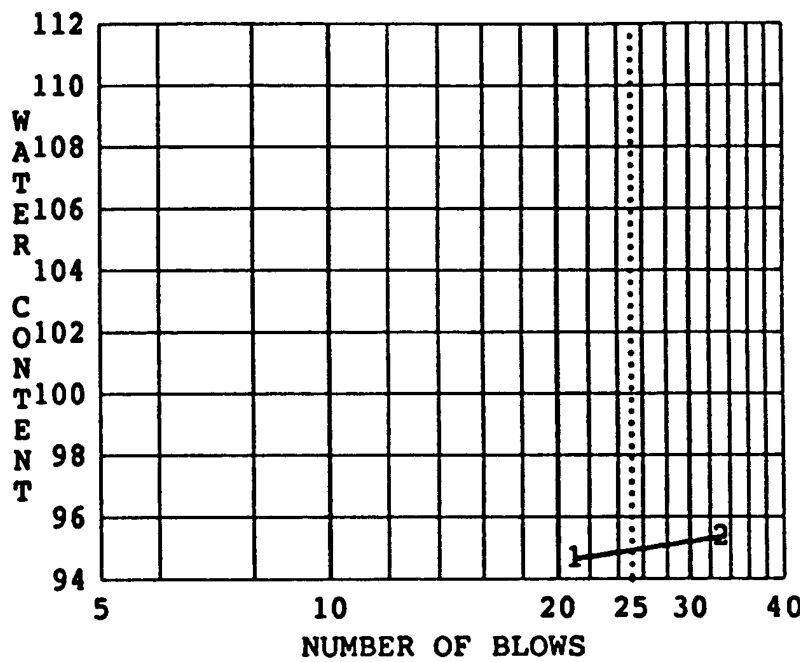
Location and description: 92-167M
D-4 18.5'- 19.5'

LIQUID LIMITS

Run No.	1	2	3	4
WT w+t	3.989	3.978		
WT dry	2.825	2.811		
WT tare	1.596	1.588		
# Blows	21	33		
Moisture	94.7	95.4		

PLASTIC LIMITS

Run No.	1	2	3
WT w+t	2.167	2.393	
WT dry	1.933	2.079	
WT tare	1.579	1.588	
Moisture	66.1	64.0	



Liquid Limit = 95
Plastic Limit = 65
Plasticity Index = 30

CLASSIFICATION DATA

%-4 = 100 %-10 = 100 %-40 = 93.7 %-200 = 58.8
Uniformity Coefficient = Curvature Coefficient =
LL = 95 PL = 65 PI = 30 LL (oven dry) = 80
ASTM = MH, Sandy elastic silt
AASHTO = A-7-5(20)

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LIQUID & PLASTIC LIMIT TEST DATA

PROJECT DATA

Project No.: 1535 Date: 7-28-92
Client: ST. PAUL DISTRICT
Project: CHASKA FLOOD CONTROL

Project location: MINNESOTA

Remarks:

Figure Number: 4

TEST DATA - Test number 3

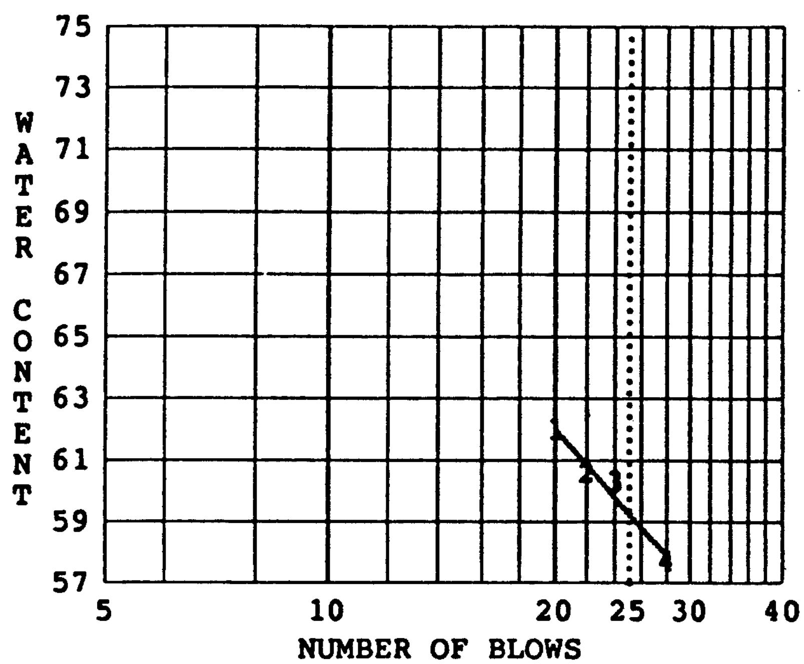
Location and description: 92-168M
D-6 17'- 20'

LIQUID LIMITS

Run No.	1	2	3	4
WT w+t	4.307	3.544	3.09	3.736
WT dry	3.274	2.806	2.526	2.948
WT tare	1.607	1.589	1.59	1.582
# Blows	20	22	24	28
Moisture	62.0	60.6	60.3	57.7

PLASTIC LIMITS

Run No.	1	2	3
WT w+t	2.634	2.457	
WT dry	2.324	2.202	
WT tare	1.592	1.576	
Moisture	42.3	40.7	



Liquid Limit = 59
Plastic Limit = 42
Plasticity Index = 17

CLASSIFICATION DATA

%-4 = 100 %-10 = 98.4 %-40 = 76.6 %-200 = 44.4
Uniformity Coefficient = Curvature Coefficient =
LL = 59 PL = 42 PI = 17 LL (oven dry) = 49
ASTM = SM, Silty sand
AASHTO = A-7-5(5)

COE - MISSOURI RIVER DIV. LAB

LIQUID & PLASTIC LIMIT TEST DATA

PROJECT DATA

Project No.: 1535 Date: 7-28-92
Client: ST. PAUL DISTRICT
Project: CHASKA FLOOD CONTROL

Project location: MINNESOTA

Remarks:

Figure Number: 5

TEST DATA - Test number 4

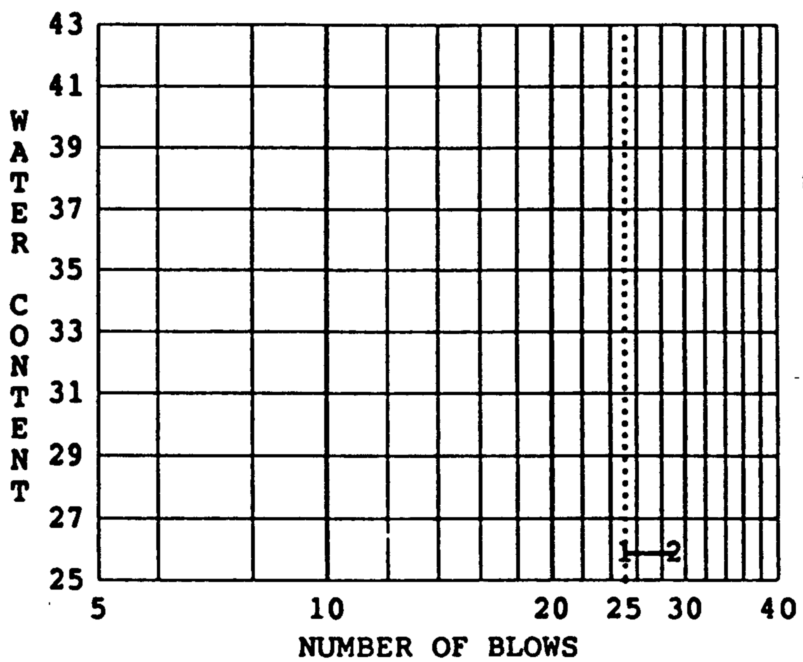
Location and description: 92-169M
D-1 3'- 4.5'

LIQUID LIMITS

Run No.	1	2	3	4
WT w+t	4.51	5.225		
WT dry	3.907	4.476		
WT tare	1.583	1.585		
# Blows	25	29		
Moisture	25.9	25.9		

PLASTIC LIMITS

Run No.	1	2	3
WT w+t	3.788	3.755	
WT dry	3.511	3.481	
WT tare	1.577	1.59	
Moisture	14.3	14.5	



Liquid Limit = 26
Plastic Limit = 14
Plasticity Index = 12

CLASSIFICATION DATA

%-4 = 99.2 %-10 = 97.7 %-40 = 81.8 %-200 = 38.9
Uniformity Coefficient = Curvature Coefficient =
LL = 26 PL = 14 PI = 12 LL (oven dry) = 25
ASTM = SC, Clayey sand
AASHTO = A-6(1)

COE - MISSOURI RIVER DIV. LAB

LIQUID & PLASTIC LIMIT TEST DATA

PROJECT DATA

Project No.: 1535 Date: 7-28-92
Client: ST. PAUL DISTRICT
Project: CHASKA FLOOD CONTROL

Project location: MINNESOTA

Remarks:

Figure Number: 6

TEST DATA - Test number 5

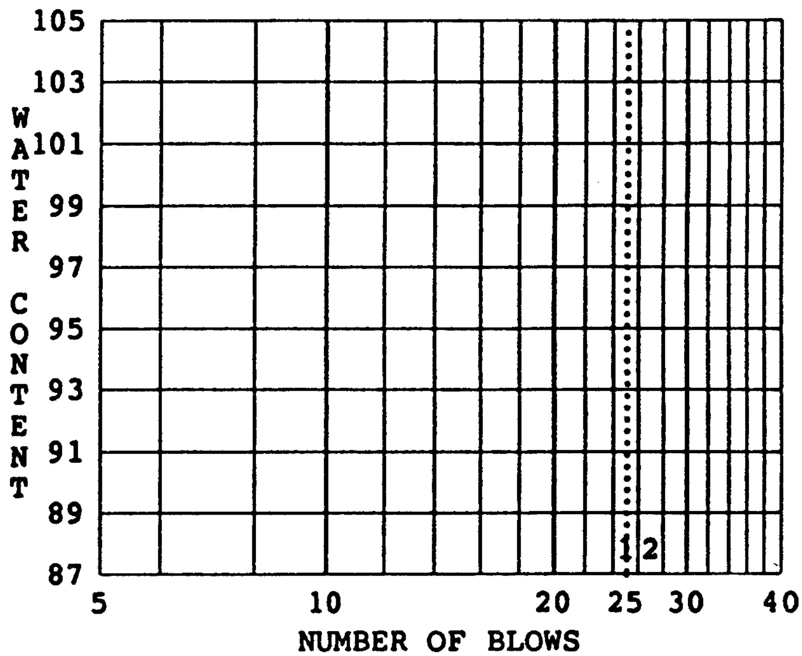
Location and description: 92-170M
D-3 6.5'- 9

LIQUID LIMITS

Run No.	1	2	3	4
WT w+t	4.392	5.561		
WT dry	3.079	3.702		
WT tare	1.584	1.584		
# Blows	25	27		
Moisture	87.8	87.8		

PLASTIC LIMITS

Run No.	1	2	3
WT w+t	2.948	2.894	
WT dry	2.515	2.483	
WT tare	1.572	1.58	
Moisture	45.9	45.5	



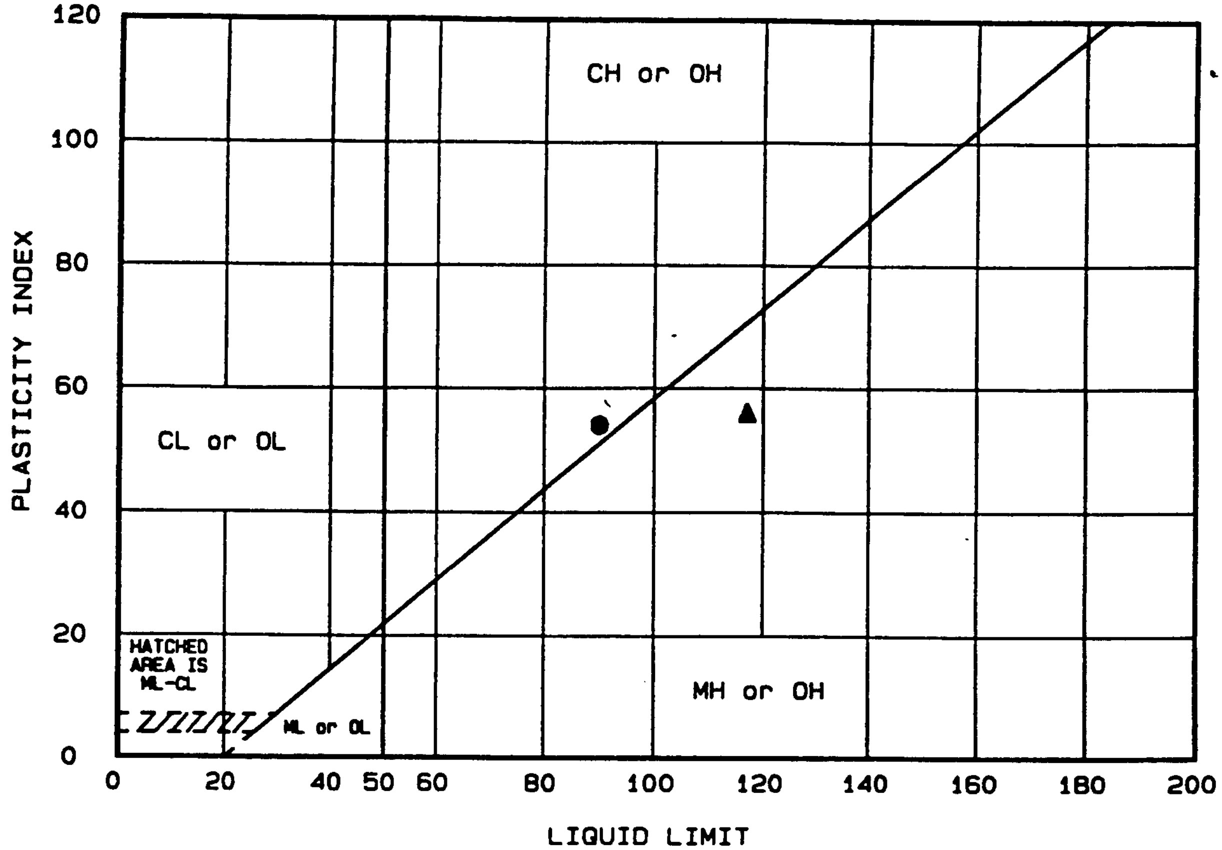
Liquid Limit = 88
Plastic Limit = 46
Plasticity Index = 42

CLASSIFICATION DATA

%-4 = %-10 = %-40 = %-200 =
Uniformity Coefficient = Curvature Coefficient =
LL = 88 PL = 46 PI = 42 LL (oven dry) = 65
ASTM = OH, Organic silt
AASHTO = A-7-5(48)

COE - MISSOURI RIVER DIV. LAB

LIQUID AND PLASTIC LIMITS TEST REPORT



	Location + Description	LL	PL	PI	-200	ASTM D 2487-85
●	92-170M D-4 12'- 13'	90	36	54	90	OH, Organic clay
▲	92-174M D-3 8'- 10'	117	61	56	90	OH, Organic silt

Project No.: 1535
Project: CHASKA FLOOD CONTROL

Client: ST. PAUL DISTRICT
Location: MINNESOTA

Date: 7-28-92

Remarks:

LIQUID AND PLASTIC LIMITS TEST REPORT

COE - MISSOURI RIVER DIV. LAB

FIGURE D-16

Fig. No. 7

LIQUID & PLASTIC LIMIT TEST DATA

PROJECT DATA

Project No.: 1535 Date: 7-28-92
Client: ST. PAUL DISTRICT
Project: CHASKA FLOOD CONTROL

Project location: MINNESOTA

Remarks:

Figure Number: 8

TEST DATA - Test number 1

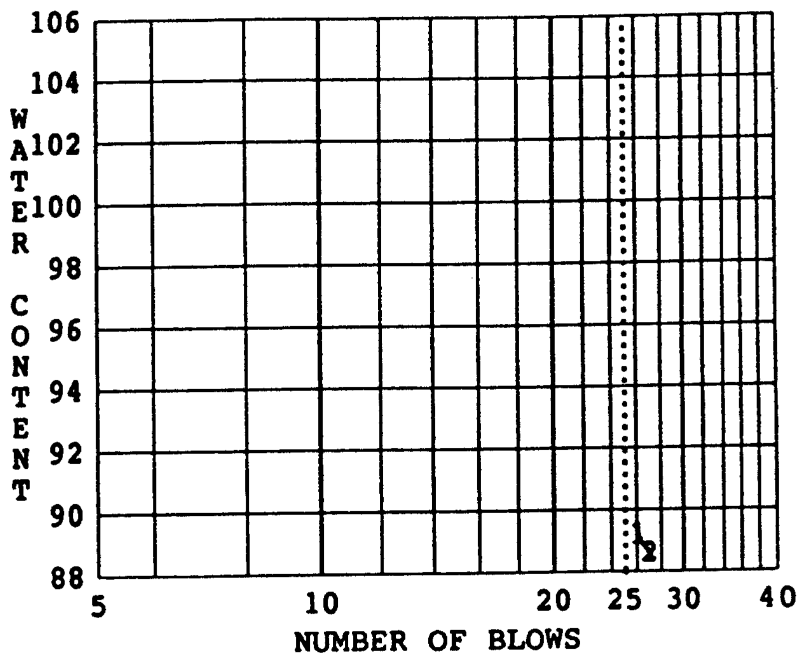
Location and description: 92-170M
D-4 12'- 13'

LIQUID LIMITS

Run No.	1	2	3	4
WT w+t	4.278	4.022		
WT dry	3.009	2.874		
WT tare	1.587	1.578		
# Blows	26	27		
Moisture	89.2	88.6		

PLASTIC LIMITS

Run No.	1	2	3
WT w+t	3.056	3.094	
WT dry	2.663	2.693	
WT tare	1.584	1.587	
Moisture	36.4	36.3	



Liquid Limit = 90
Plastic Limit = 36
Plasticity Index = 54

CLASSIFICATION DATA

%-4 = %-10 = %-40 = %-200 =
Uniformity Coefficient = Curvature Coefficient =
LL = 90 PL = 36 PI = 54 LL (oven dry) = 60
ASTM = OH, Organic clay
AASHTO = A-7-5(57)

COE - MISSOURI RIVER DIV. LAB

LIQUID & PLASTIC LIMIT TEST DATA

PROJECT DATA

Project No.:	1535	Date: 7-28-92
Client:	ST. PAUL DISTRICT	
Project:	CHASKA FLOOD CONTROL	
Project location:	MINNESOTA	

Remarks:

Figure Number: 9

TEST DATA - Test number 2

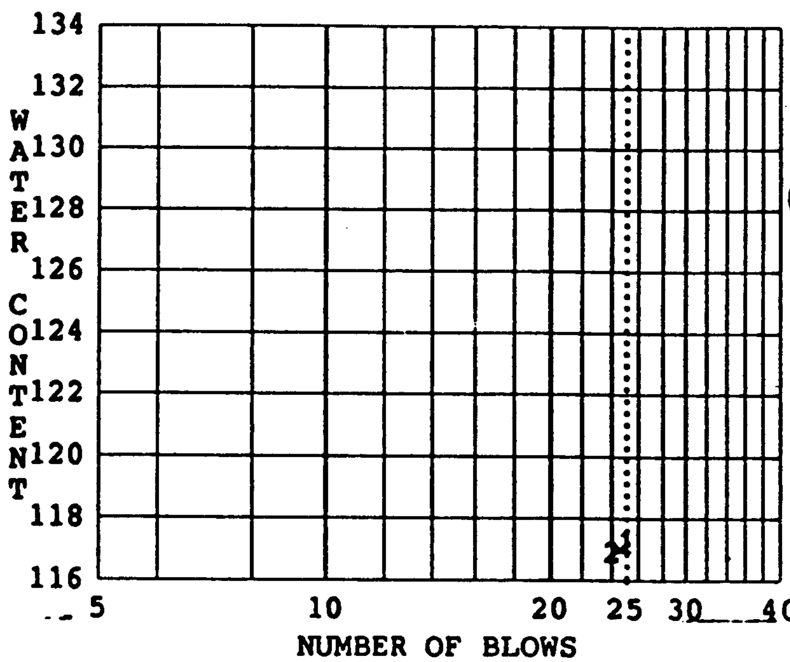
Location and description: 92-174M
D-3 8'- 10'

LIQUID LIMITS

Run No.	1	2	3	4
WT w+t	4.036	3.707		
WT dry	2.713	2.56		
WT tare	1.584	1.579		
# Blows	25	24		
Moisture	117.2	116.9		

PLASTIC LIMITS

Run No.	1	2	3
WT w+t	2.739	2.837	
WT dry	2.301	2.361	
WT tare	1.578	1.573	
Moisture	60.6	60.4	



Liquid Limit = 117
Plastic Limit = 61
Plasticity Index = 56

CLASSIFICATION DATA

%-4 = %-10 = %-40 = %-200 =
Uniformity Coefficient = Curvature Coefficient =
LL = 117 PL = 61 PI = 56 LL (oven dry) = 67
ASTM = OH, Organic silt
AASHTO = A-7-5(67)

COE - MISSOURI RIVER DIV. LAB

SOIL CLASSIFICATION RECORD SHEET

PROJECT: Chaska Flood Control, East Creek Stage 3	BORING: 92-195M through 92-200M	MRD LAB NO. 1897
STATION: / RANGE: / SURF.ELEV.:	DEPTH TO WATER TABLE:	DATE: 8 March 1993

SAMP NO.	DEPTH TO BOTTOM OF SAMP.	MOISTURE (%)	PLASTICITY (ATT. LIMITS) LL	PI	GRADING (CUMULATIVE PERCENTS FINER) HYD. ANALYSIS FINES .005	.02mm	U.S. STANDARD SIEVE SIZE SANDS 200	80	40	20	10	4	GRAVEL 3/8	3/4	1-1/2	3 IN	GRADATION CURVE ANALYSIS D60 (mm)	D30 (mm)	D10 (mm)	Cu	Cc	Dried in 140 Oven?	CLASSIFICATION TECH MEMO 3-357, MAY 67	REMARKS	PL
Hole	92-195M																								
6	27.5	39.2	34	15																			Lean Clay CL		19
7	29.5	38.9	68	38																			Fat Clay CH		30
8	32.5	201.6	268	124																		Y	Organic Silt OH		144
10	44.5	60.7	75	31																		Y	Silt MH	With some organics	44
Hole	92-196M																								
1	9.0	104.1	91	31																		Y	Silt MH	With organics	60
3	19.5	113.5	82	29																		Y	Silt MH	With organics	53
5	29.5	104.8	101	39																		Y	Silt MH	With organics	62
6	34.5	117.4	149	63																		Y	Organic Silt OH		86
9	49.5	32.2	51	32																		Y	Organic Silt OH		19
Hole	92-197M																								
1	2.5	37.1	45	18																		Y	Clayey Silt ML	With some organics	27
3	8.4	61.3	111	50																		Y	Organic Silt OH		61
4	12.0	260.0	274	86																		Y	Organic Silt OH		188
Hole	92-198M																								
2	9.0	243.6	134	55																		Y	Organic Silt OH		79
4	19.5						3	16	85	96	96	96	97	100			0.31	0.21	0.12	2.60	1.22		Sand SP		
6	27.0						4	8	33	78	96	100					0.63	0.40	0.21	3.00	1.21		Sand SP		
Hole	92-199M																								
1	10.0		35	21			30	46	68	85	95	99	100										Clayey Sand SC		14
2	4.0						8	19	58	82	95	99	100				0.44	0.24	0.11	4.08	1.17		Silty Sand SP-SM		
3	8.5	40.1	75	48																			Fat Clay CH		27
4	11.5						12	24	63	84	97	100					0.40	0.21	0.05	7.92	2.15		Silty Sand SW-SM		
5	15.0	32.8	58	39																			Fat Clay CH		19
6	17.0	38.4	56	38																			Fat Clay CH		18
7	19.5	27.2	22	3																			Silt ML		19
8	21.5						7	10	47	65	67	70	73	84	100		0.68	0.28	0.18	3.78	0.66		Silty Gravelly Sand SP-SM		
Hole	92-200M																								
4	10.0	34.0	49	32																			Lean Clay CL		17
5	12.0	15.8	17	2																			Silt ML		15
6	14.5						2	6	41	77	97	100					0.59	0.32	0.20	2.98	0.89		Sand SP		
9	24.5	38.6	39	20																			Lean Clay CL		19
10	29.0						10	20	37	50	61	77	96	100			1.79	0.30	0.08	23.75	0.65		Silty Gravelly Sand SP-SM		
12	39.5						12	25	57	73	83	94	100				0.47	0.21	0.06	7.80	1.50		Silty Sand SW-SM		

TABLE 1

FIGURE D-19

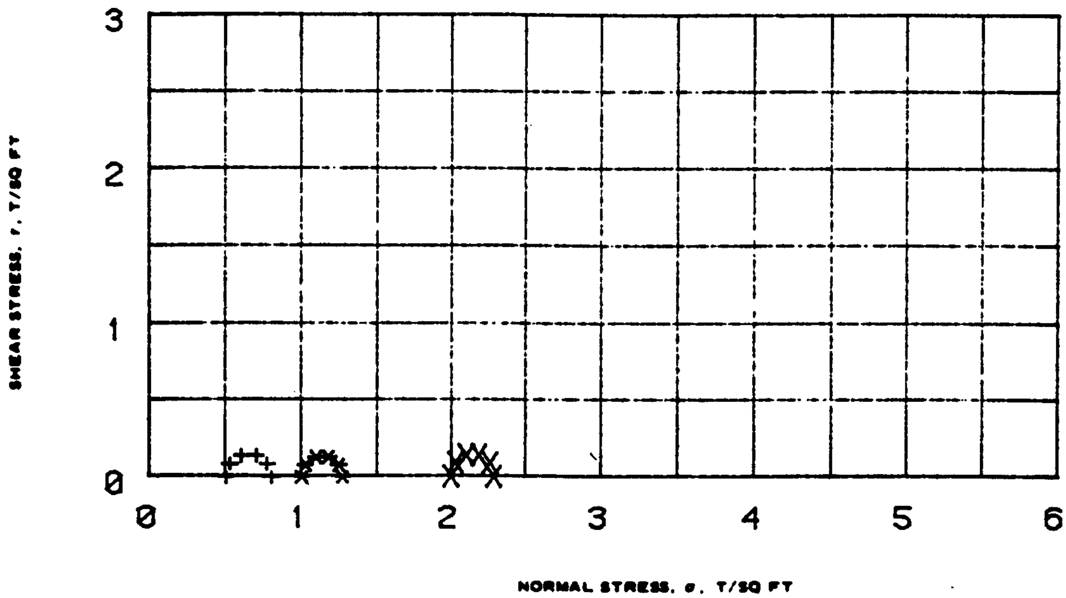
SOIL CLASSIFICATION RECORD SHEET

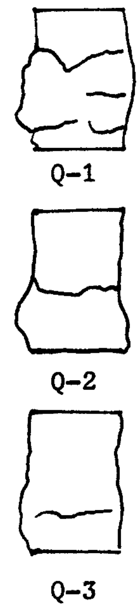
PROJECT: Chaska Flood Control, East Creek Stage 3 | BORING: 92-201M through 92-203M | MRD LAB NO. 1897

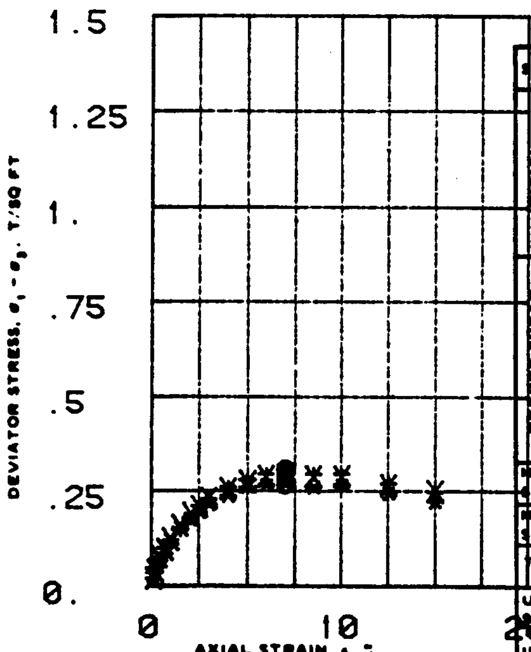
STATION: | RANGE: | SURF.ELEV.: | DEPTH TO WATER TABLE: | DATE: 8 March 1993

SAMP NO.	DEPTH TO BOTTOM OF SAMP	MOISTURE (%)	PLASTICITY (ATT. LIMITS) LL	PI	GRADING (CUMULATIVE PERCENTS FINER) HYD. ANALYSIS FINES .005	.02mm	U.S. STANDARD SIEVE SIZE 200	SANDS 80	40	20	10	4	GRAVEL 3/8	3/4	1-1/2	3 IN	GRADATION CURVE ANALYSIS D60 (mm)	D30 (mm)	D10 (mm)	Cu	Cc	Dried in 140 Oven?	CLASSIFICATION TECH MEMO 3-357, MAY 67	REMARKS	PL
Hole	92-201M																								
1	1.5	16.4	42	22																		Y	Lean Clay CL	With some organics	20
2	3.8	78.2	111	53																		Y	Organic Silt OH		58
3	8.6						11	17	45	87	98	99	100				0.56	0.30	0.05	11.14	3.29		Silty Sand SP-SM		
4	9.5	25.7	34	20																		Y	Lean Clay CL	With some organics	14
5	11.0	28.1	31	16																			Lean Clay CL		15
6	14.0	17.5	17	2																			Silt ML		15
7	15.0						50	73	90	96	98	99	100										Silty Sand SM		
9	24.2	26.3	20	5																			Clayey Silt ML-CL		15
Hole	92-202M																								
1	9.0		35	19			49	63	78	89	95	99	100										Clayey Sand SC		16
2	3.0	24.6	37	19																			Lean Clay CL		18
4	13.0	25.4	32	17																			Lean Clay CL		15
Hole	92-203M																								
1	10.0		35	18			55	71	86	94	98	99	100										Sandy Clay CL		17
2	5.0	23.0	35	14																			Lean Clay CL		21

TABLE 2







SPECIMEN NO.			1	2	3	
INITIAL	WATER CONTENT, %	w_o	81.8	77.6	95.6	
	DRY DENSITY LB/CU FT	γ_{d_o}	50.7	52.9	44.9	
	SATURATION, %	S_o	100.	[illegible]	100.	
	VOID RATIO	e_o	1.83	1.71	2.2	
BEFORE SHEAR	WATER CONTENT, %	w_c	81.3	78.1	95.2	
	DRY DENSITY LB/CU FT	γ_{d_c}	50.7	52.9	44.9	
	SATURATION, %	S_c	100.	100.	100.	
	VOID RATIO	e_c	1.83	1.71	2.2	
	FINAL BACK PRESSURE, T/SQ FT	u_o	0.	0.	0.	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.5	1.	2.	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	.303	.271	.291	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	15	12	15	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	.25	.225	.251	
INITIAL DIAMETER, IN.		D_o	1.39	1.39	1.39	
INITIAL HEIGHT, IN.		H_o	2.96	2.96	2.98	

CONTROLLED- TEST

DESCRIPTION OF SPECIMENS Organic fat clay, ~~CH~~ OH

LL 98	PL 36	PI 62	Gs 2.5	TYPE OF SPECIMEN	UNDISTURBED	TYPE OF TEST	Q

REMARKS: Gray, soft condistency, low strength at PL, no shine, fast shake response, wooden chips and roots.

PROJECT CHASKA NCS-IA-82-128-ED-GH

BORING NO 82-42 SAMPLE NO. 2

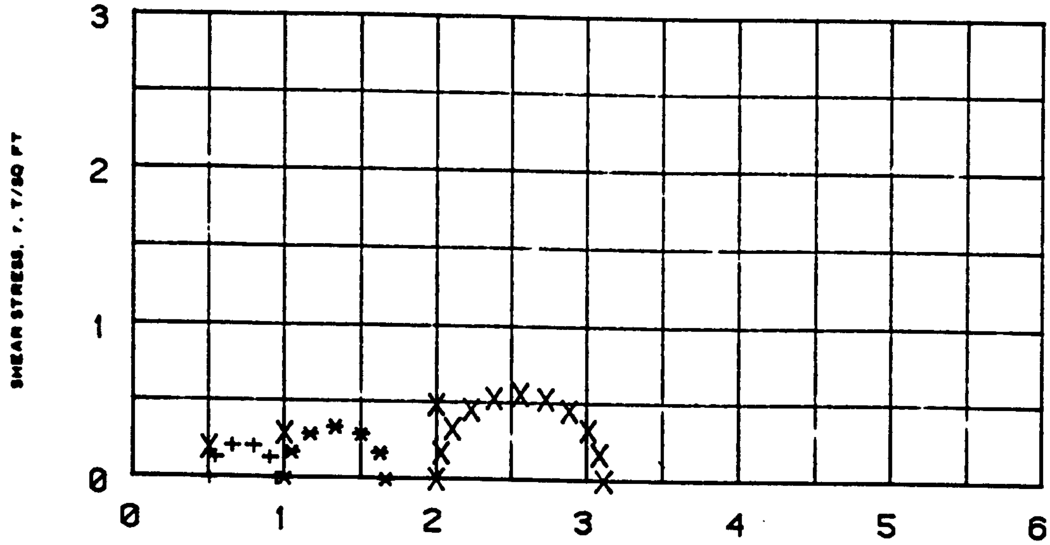
DEPTH ELEV 10.0-11.4

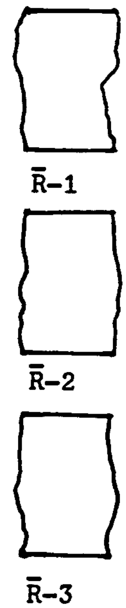
LABORATORY 83/87 DATE 08 MAR 1983

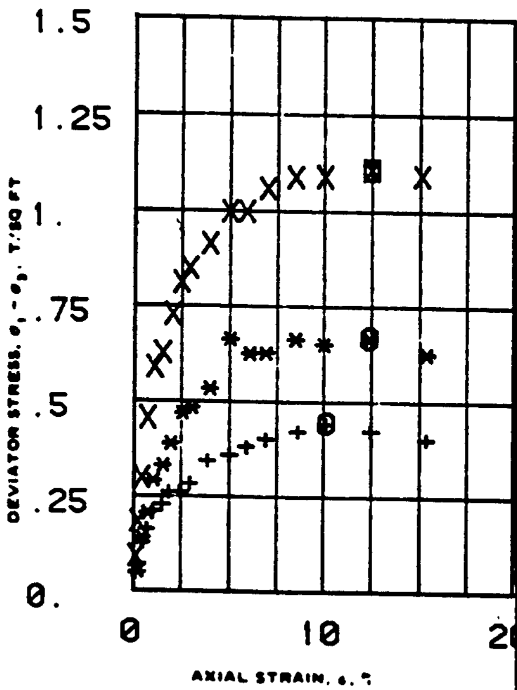
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

Figure 1







SPECIMEN NO.			1	2	3	
INITIAL	WATER CONTENT, %	w_o	116.	115.	114.	
	DRY DENSITY LB/CU FT	γd_o	38.6	39.2	59.4	
	SATURATION, %	S_o	99.	99.	99.	
	VOID RATIO	e_o	2.72	2.66	2.64	
BEFORE SHEAR	WATER CONTENT, %	w_c	98.1	103.9	71.4	
	DRY DENSITY LB/CU FT	γd_c	45.8	51.2	59.	
	SATURATION, %	S_c	100.	100.	100.	
	VOID RATIO	e_c	2.14	1.8	1.44	
	FINAL BACK PRESSURE, T/SQ FT	u_o	1.9	1.9	1.9	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.5	1.	2.	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	.444	.669	1.11	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	750	900	870	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	.405	.629	1.1	
INITIAL DIAMETER, IN.		D_o	1.39	1.39	1.39	
INITIAL HEIGHT, IN.		H_o	2.99	2.99	3.	

CONTROLLED- STRAIN TEST

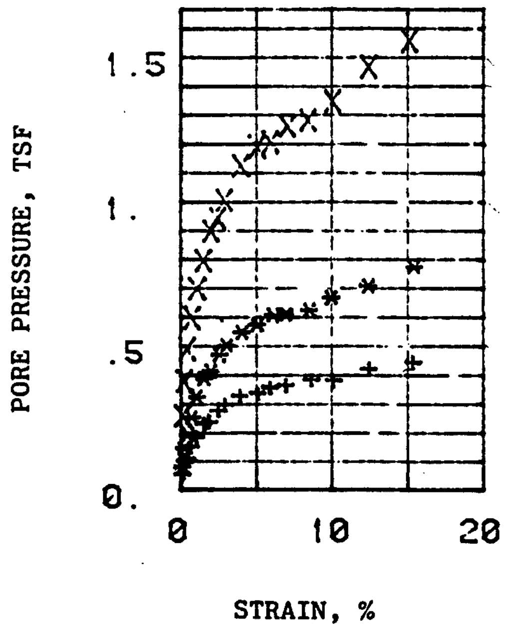
DESCRIPTION OF SPECIMENS Organic clay, ~~CH~~ OH

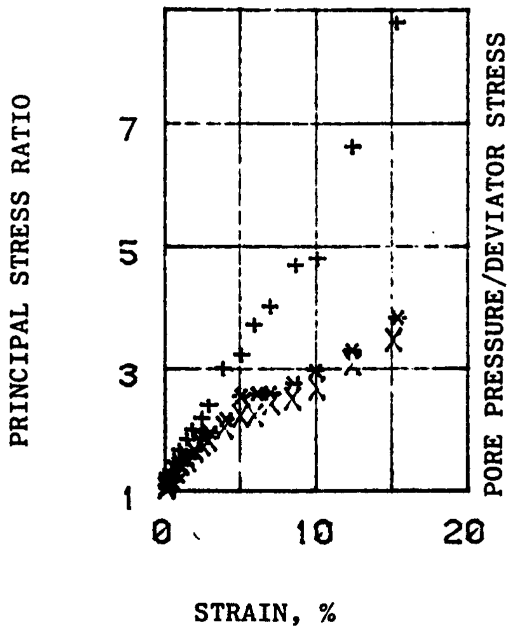
LL 98	PL 36	PI 62	Gs 2.5	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST $\bar{R}$

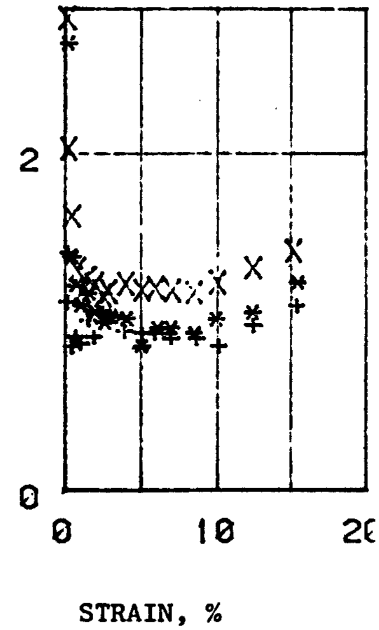
REMARKS:	PROJECT CHASKA NCS-IA-82-128-ED-GH
	BORING NO 82-42 — SAMPLE NO. 2
	DEPTH ELEV 10.-11.4
	LABORATORY 85/87 — DATE 08 MAR 1983
B value = 1.00	TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

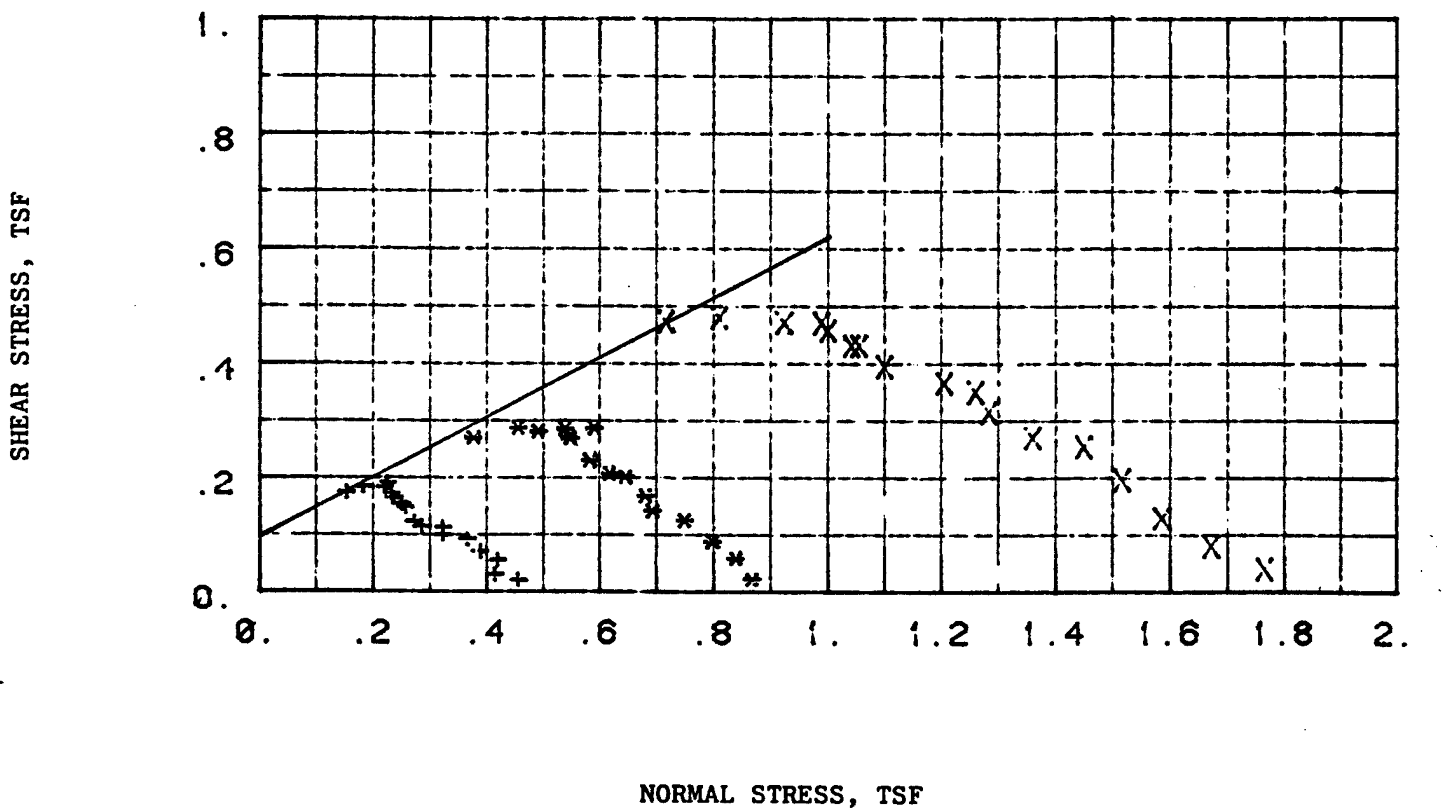
Figure 2







EFFECTIVE STRESS VECTOR CURVES ON 60DEGREE PLANE



REMARKS: COMPUTER PRINT-OUT
SYMBOLS SAME AS FORM 2089
R̄ TRIAXIAL TEST: PORE PRESSURE
MONITORED DURING SHEAR

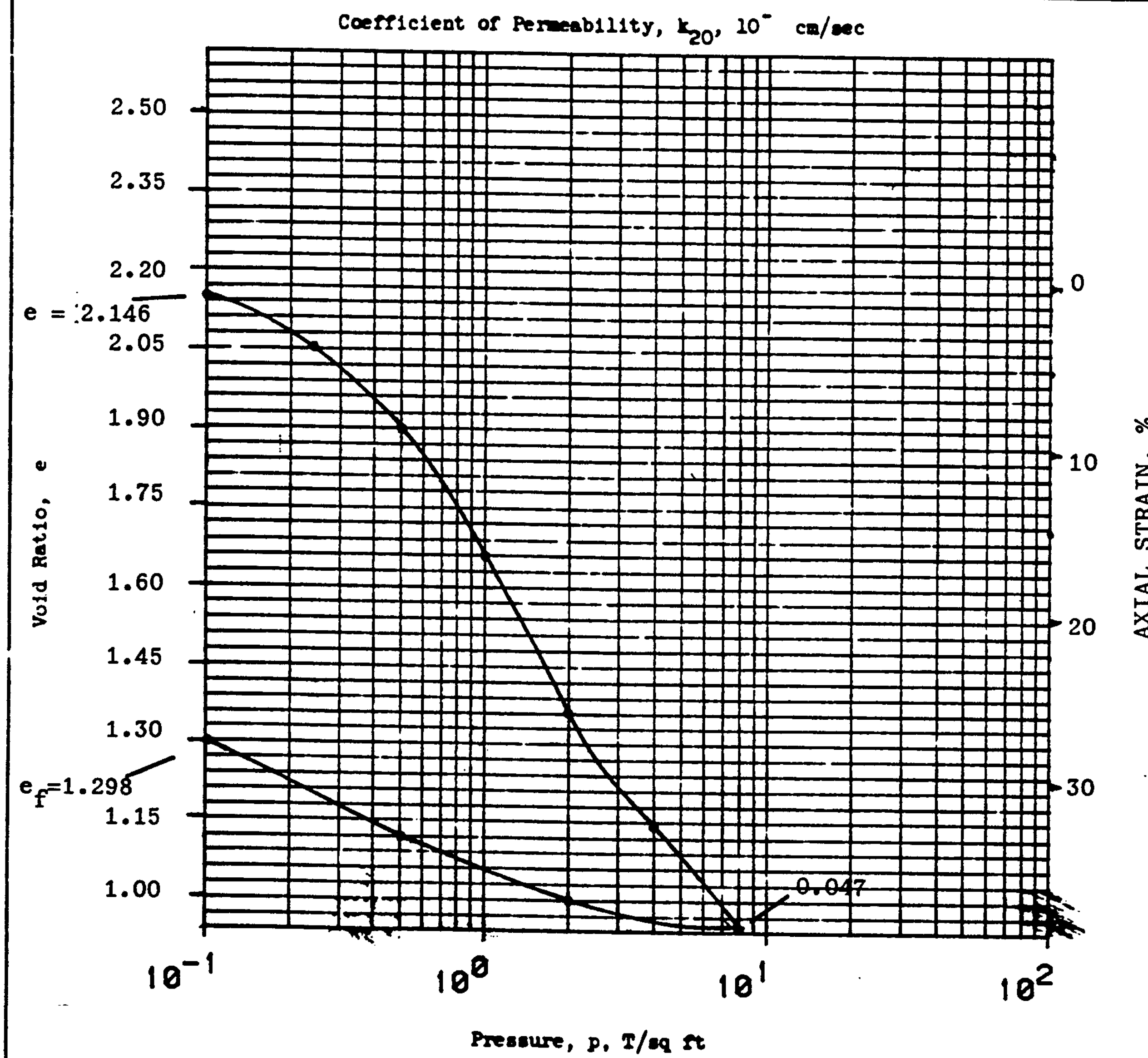
PROJECT:	CHASKA NCS-IA-82-126-ED-GH		
BORING NO:	82-42	SAMPLE NO:	2
DEPTH/ELEV:	10.-11.4		
MRD LAB NO:	85/87	DATE:	08 MAR 1983

TRIAXIAL COMPRESSION TEST REPORT

FIGURE: 3

MRD Form 756, 1 May 80

FIGURE D-23



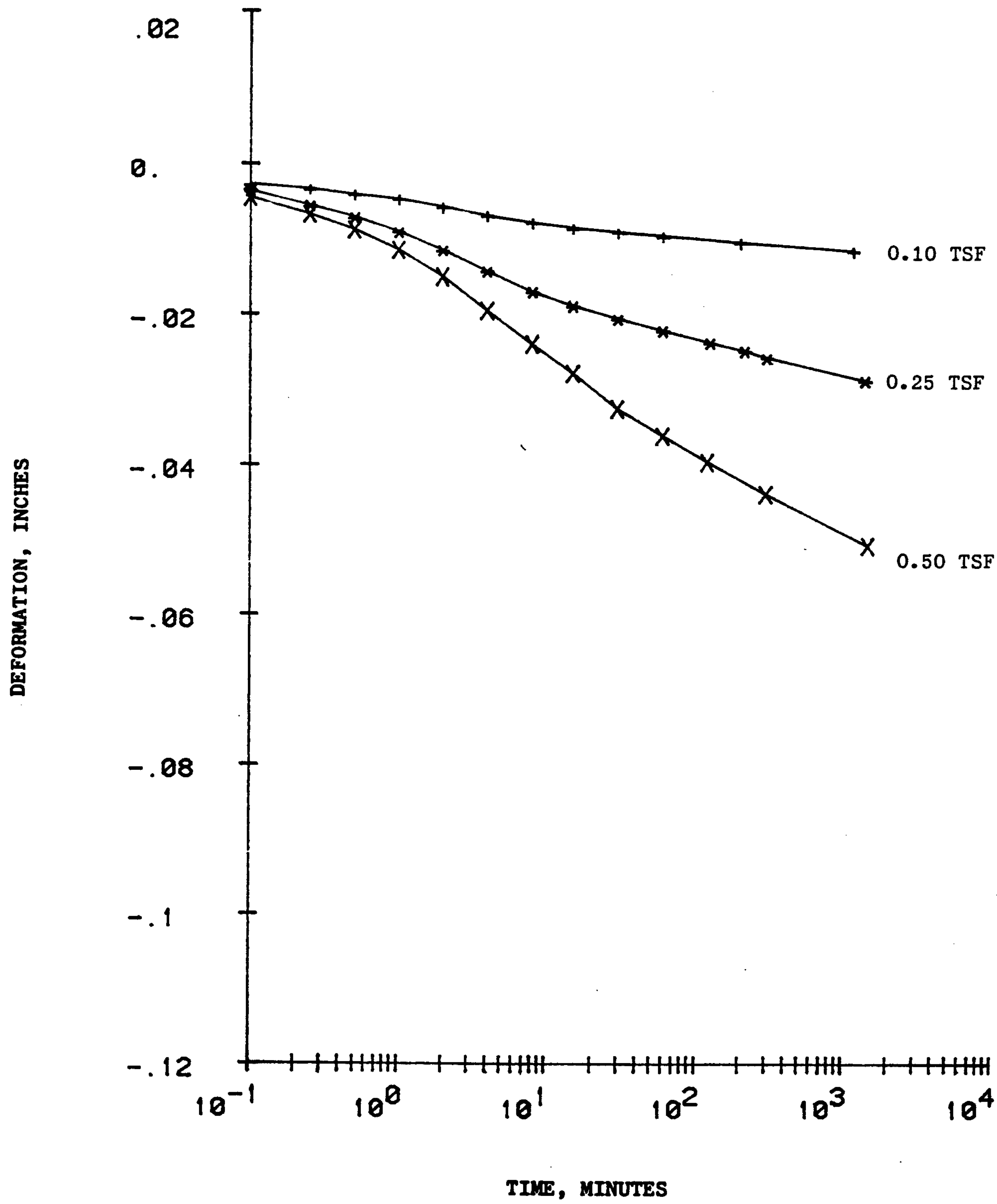
Type of Specimen UNDISTURBED		Before Test	After Test
Diam 4.28 in.	Ht .998 in.	Water Content, w_o 89. %	w_f 64.4 %
Overburden Pressure, p_o T/sq ft		Void Ratio, e_o 2.18	e_f 1.3
Preconsol. Pressure, p_c T/sq ft		Saturation, S_o 94. %	S_f 100. %
Compression Index, C_c		Dry Density, γ_d 45.1 lb/ft^3	
Classification Organic clay, OH		k_{20} at e_o = x 10⁻ cm/sec	
LL 98	G_s 2.3	Project CHASKA NCS-IA-82-126-ED-GH	
PL 36	D_{10}		
Remarks Note the secondary consolidation		Area MRD LAB NO: 83/67	
		Boring No. 82-42MU	Sample No. 2
		Depth El 10.0-11.4	Date 24 MAR 1983

CONSOLIDATION TEST REPORT

ENG FORM 1 MAY 63 2090 PREVIOUS EDITIONS ARE OBSOLETE.

Figure 1

FIGURE D-24



PROJECT: CHASKA NCS-IA-82-126-ED-GH

MRD LAB NO: 83/67

DATE: 24 MAR 1983

BORING NO: 82-42MU SAMPLE NO: 2

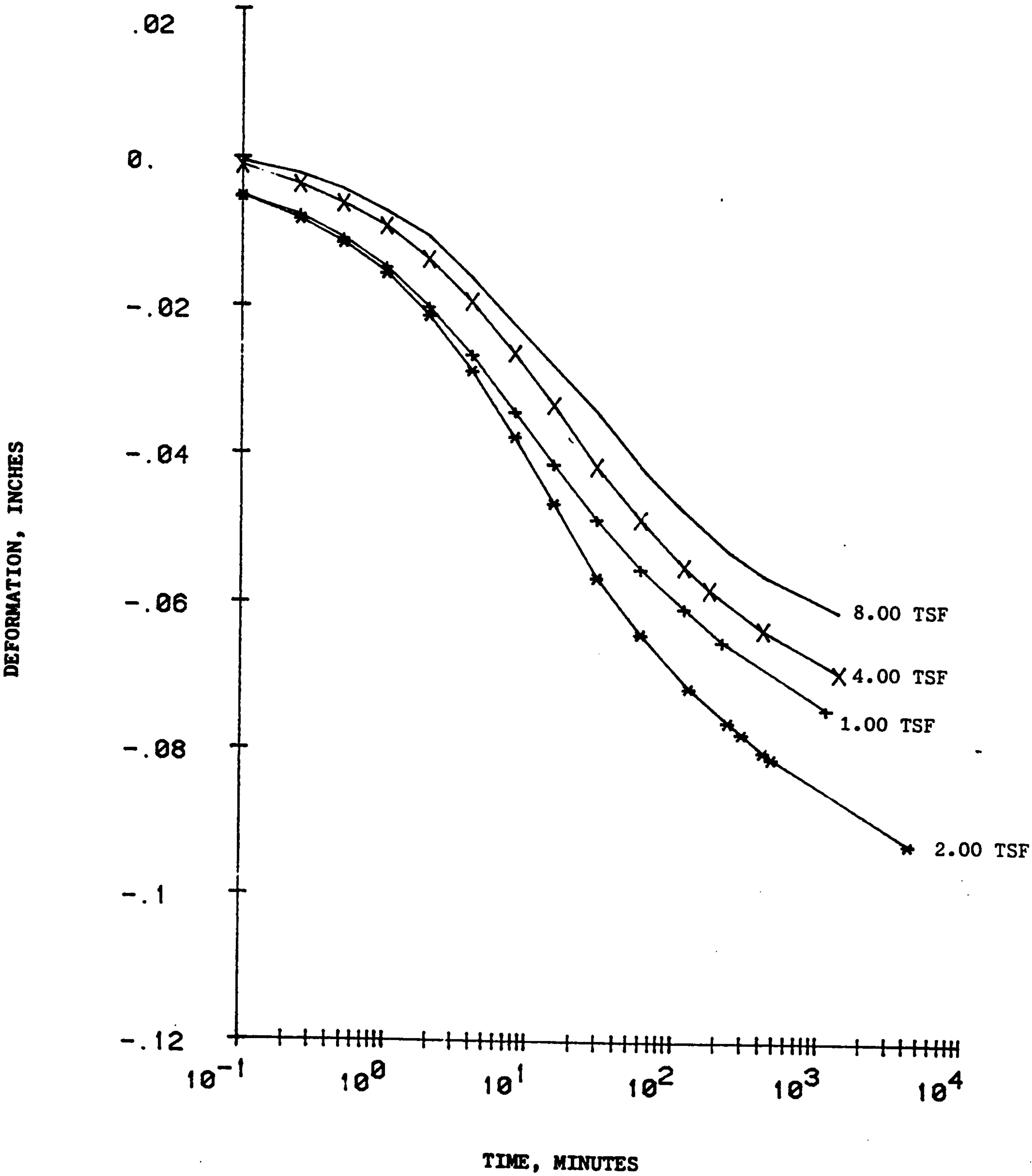
DEPTH/ELEV: 10.0-11.4

CONSOLIDATION TEST—TIME CURVES

FIGURE: 2

COMPUTER PRINT-OUT FORMAT
SAME AS ENG FORM 2088

MRD Form 956, 1 May 80



PROJECT: CHASKA NCS-IA-82-126-ED-GH

MRD LAB NO: 83/67

DATE: 24 MAR 1983

BORING NO: 82-42MU SAMPLE NO: 2

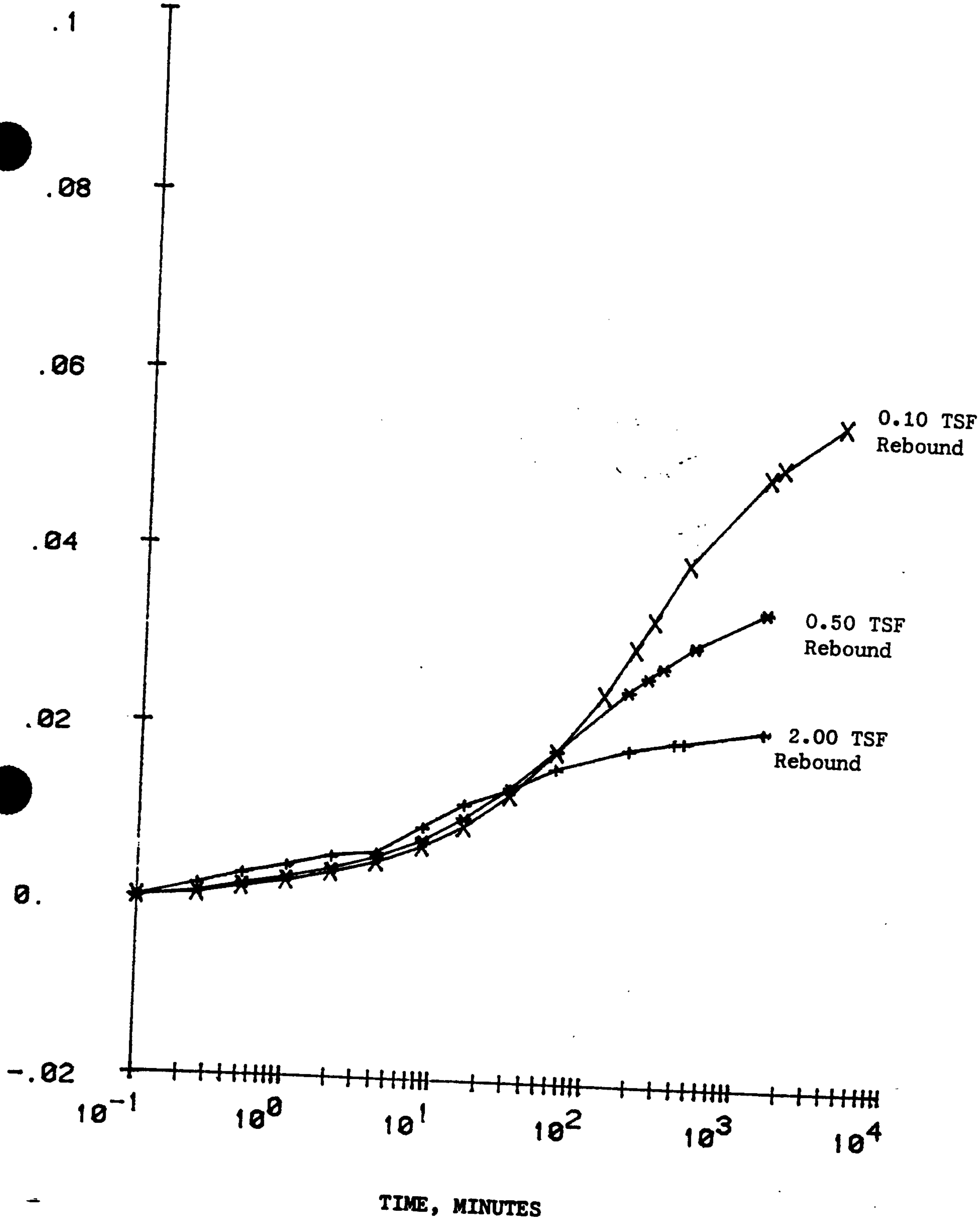
DEPTH/ELEV: 10.0-11.4

COMPUTER PRINT-OUT FORMAT
SAME AS ENG FORM 2088

CONSOLIDATION TEST—TIME CURVES

FIGURE: 3

25



CHASKA NCS-IA-82-126-ED-GH

83/67

82-42MU SAMPLE NO: 2

DATE: 24 MAR 1983

DEPTH/ELEV: 10.0-11.4

-OUT FORMAT
FORM 2088

CONSOLIDATION TEST—TIME CURVES

FIGURE: 4

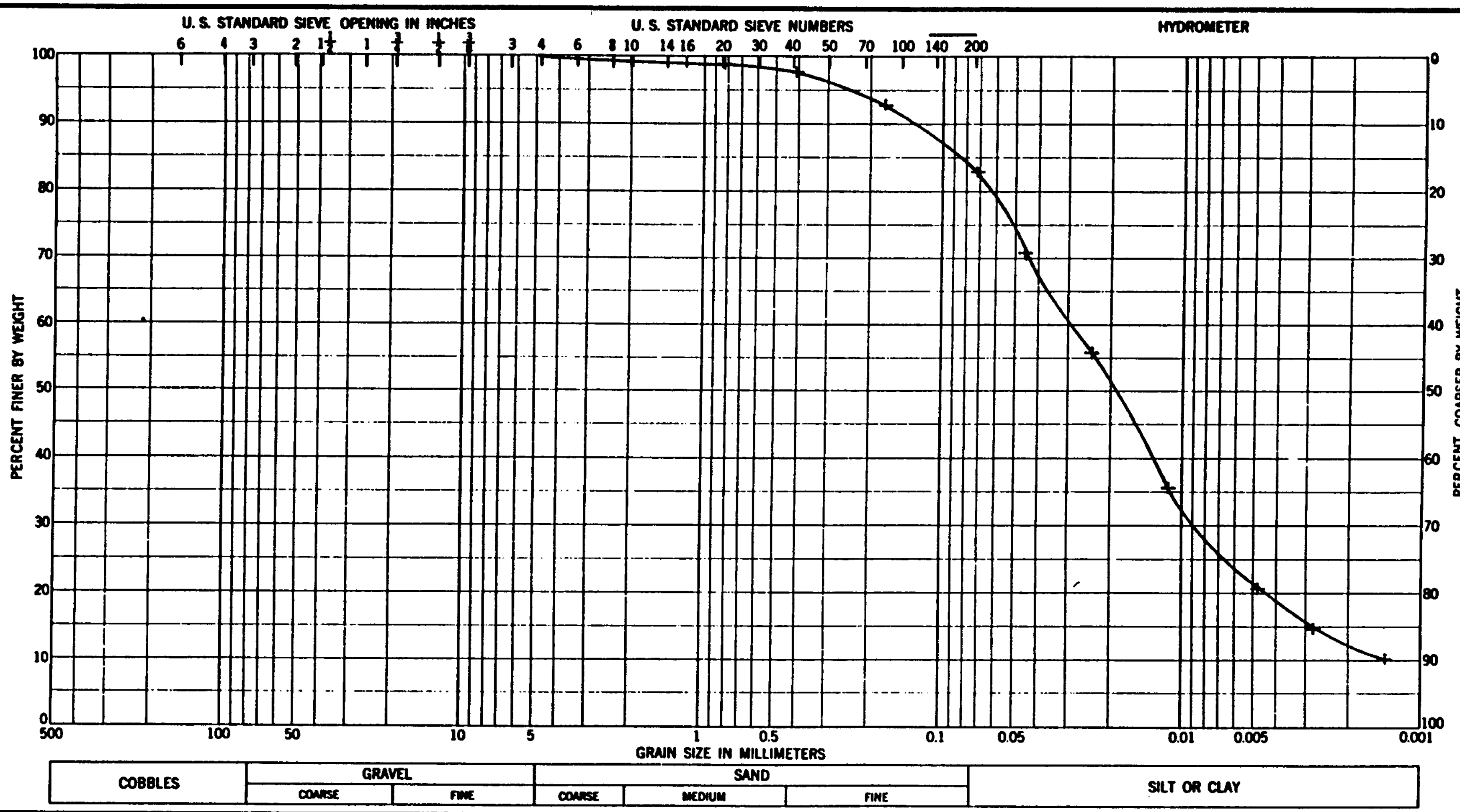
GRADATION CURVES

Date

FIGURE 4

ENG FORM 1 MAY 63 2087

ly 80



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
2		Organic fat clay, ~~CH~~ OH		98	36	62

Project	CHASKA
Area	MRD LAB NO. 83/67
Boring No.	82-42 MU
Date	08 MAR 1983

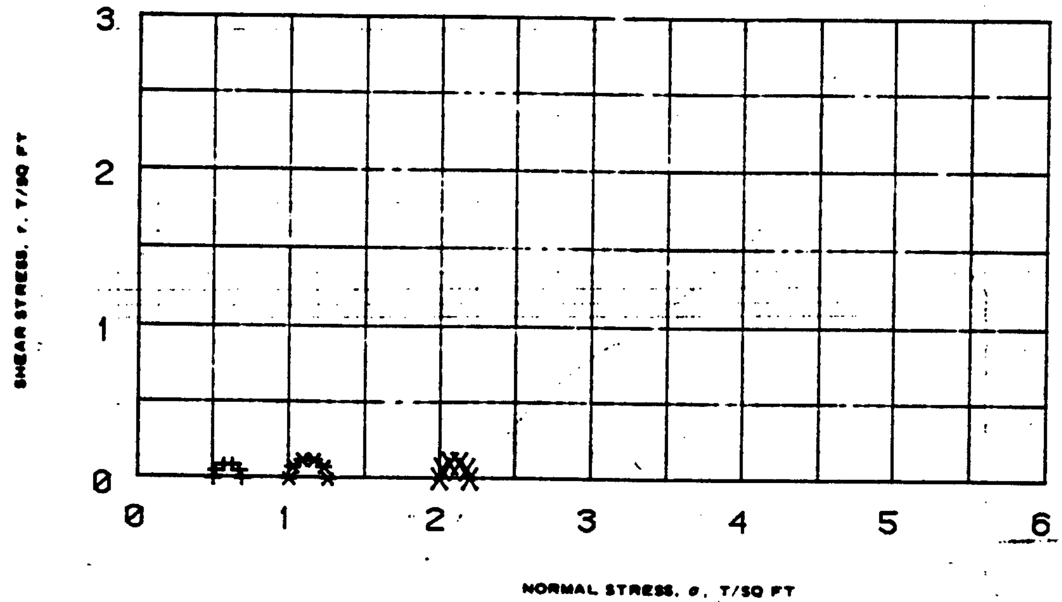
GRADATION CURVES

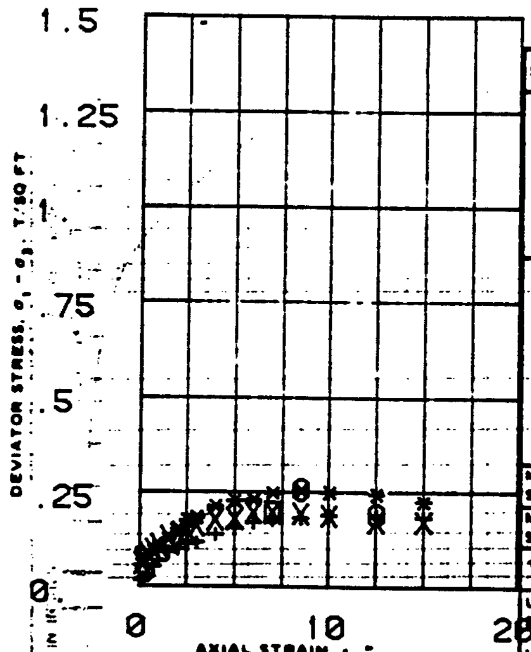
ENG FORM 1 MAY 63 2087

FIGURE 4

~~FIGURE D-28~~

27





SPECIMEN NO.			1	2	3	
INITIAL	WATER CONTENT, %	w_o	225.	242.	227.	
	DRY DENSITY LB/CU FT	γ_{d_o}	22.6	20.0	22.5	
	SATURATION, %	S_o	98.	95.	97.	
	VOID RATIO	e_o	5.05	5.56	5.12	
BEFORE SHEAR	WATER CONTENT, %	w_c	222.	242.	227.	
	DRY DENSITY LB/CU FT	γ_{d_c}	22.6	20.0	22.3	
	SATURATION, %	S_c	98.	95.	97.	
	VOID RATIO	e_c	5.05	5.56	5.12	
	FINAL BACK PRESSURE, T/SQ FT	u_o	0.	0.	0.	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.5	1.	2.	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	.193	.250	.190	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	23	10	14	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	.180	.229	.175	
INITIAL DIAMETER, IN.		D_o	1.4	1.4	1.39	
INITIAL HEIGHT, IN.		H_o	2.93	2.99	3.00	

CONTROLLED- TEST

DESCRIPTION OF SPECIMENS Sandy organic clay, OH

LL 212	PL 87	PI 125	G_s 2.19	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST Q

REMARKS: Mottled gray, soft consistency, low strength at PL, dull shine, fast shake response, calcareous, musty odor.

PROJECT CHASKA NCS-IA-82-128-ED-GH

BORING NO 82-42 SAMPLE NO. 3

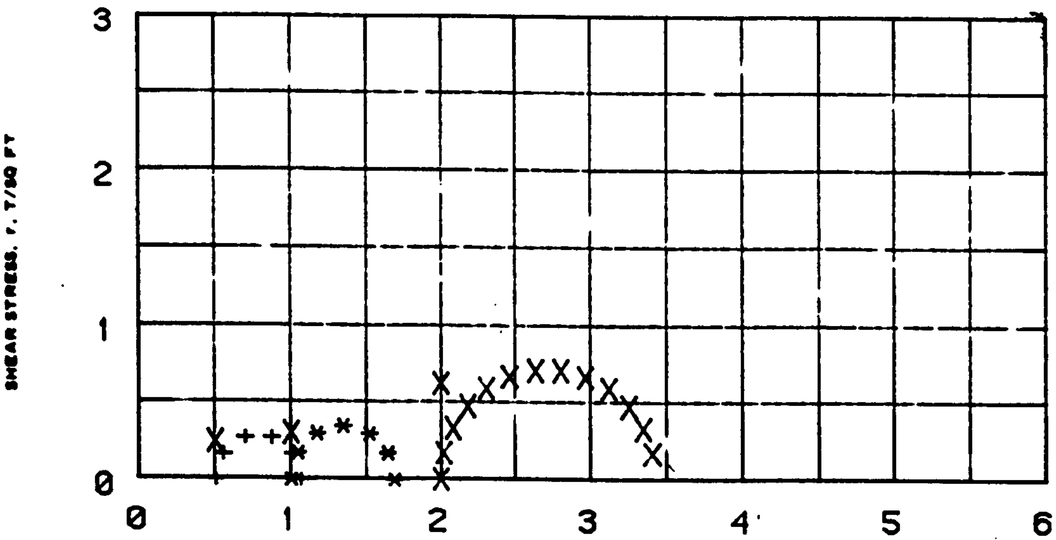
DEPTH ELEV 15.0-18.3

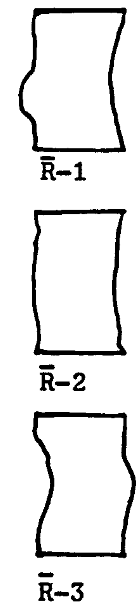
LABORATORY 83/87 DATE 08 MAR 1983

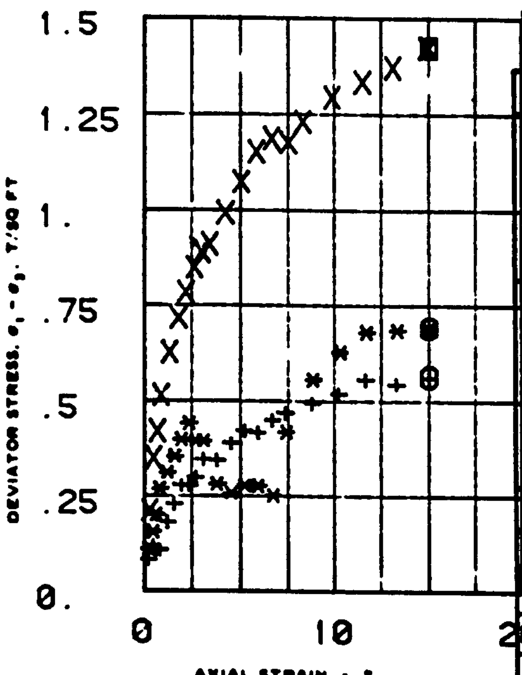
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

Figure 5







SPECIMEN NO.			1	2	3	
INITIAL	WATER CONTENT, %	w_o	356.	338.	387.	
	DRY DENSITY LB/CU FT	γ_{d_o}	15.2	15.8	17.6	
	SATURATION, %	S_o	98.	97.	98.	
	VOID RATIO	e_o	7.99	7.65	6.83	
BEFORE SHEAR	WATER CONTENT, %	w_c	248.	203.	142.	
	DRY DENSITY LB/CU FT	γ_{d_c}	21.5	22.9	37.1	
	SATURATION, %	S_c	100.	89.	100.	
	VOID RATIO	e_c	5.37	4.97	2.69	
	FINAL BACK PRESSURE, T/SQ FT	u_o	1.9	1.9	1.9	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.5	1.	2.	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	.564	.692	1.43	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	1382	1297	1283	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	.564	.692	1.43	
INITIAL DIAMETER, IN.		D_o	1.39	1.38	1.39	
INITIAL HEIGHT, IN.		H_o	2.99	3.	2.99	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Sandy organic clay, OH

LL 212	PL 87	PI 125	G_s 2.19	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST R̄

REMARKS: Pore pressures at 13.3 and 15.0% were approximated for specimen number 1. There was no correction for the membrane around each specimen.

B value = 1.00

PROJECT CHASKA NCS-IA-82-128-ED-GH

BORING NO 82-42 SAMPLE NO. 3

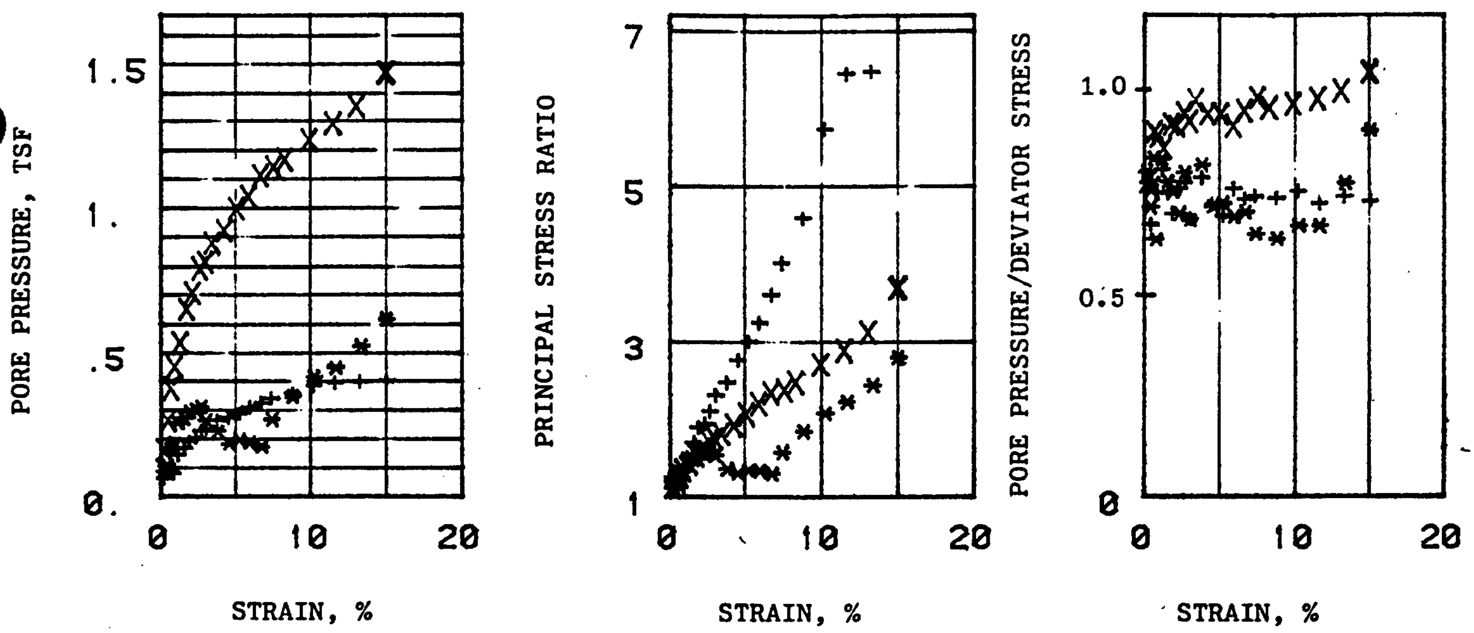
DEPTH ELEV 15.-16.3

LABORATORY 83/87 DATE 08 MAR 1983

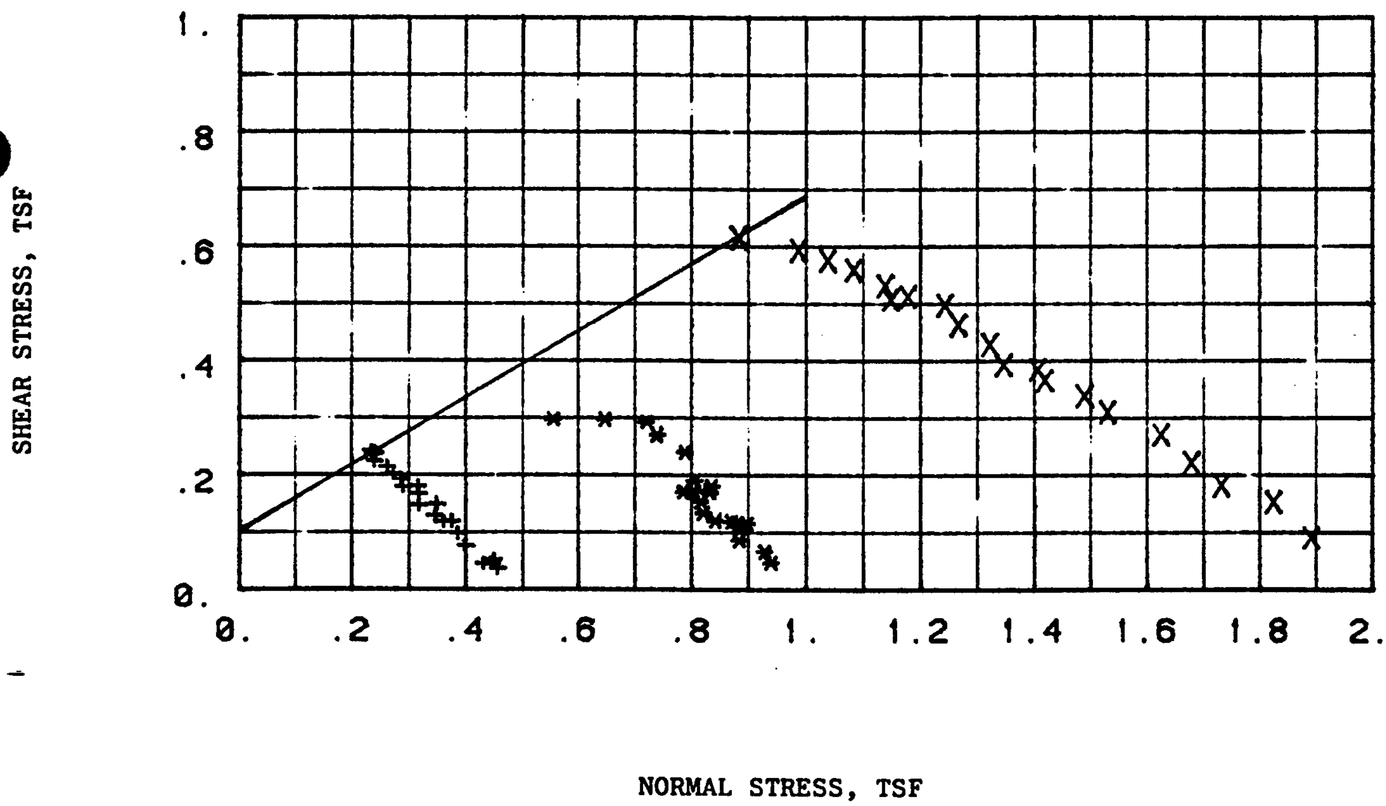
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

Figure 6



EFFECTIVE STRESS VECTOR CURVES ON 60 DEGREE PLANE



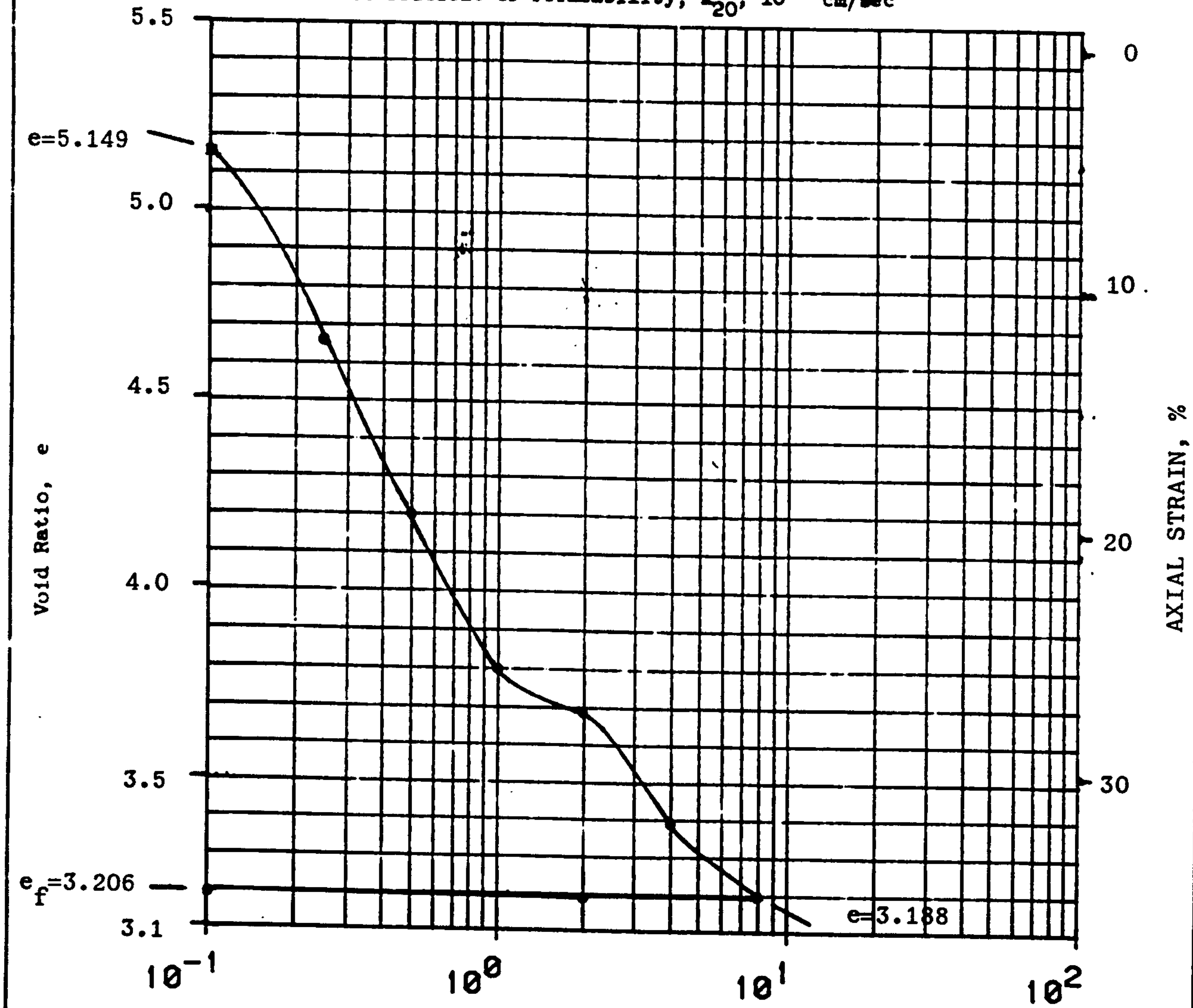
REMARKS: COMPUTER PRINT-OUT
SYMBOLS SAME AS FORM 2089
R TRIAXIAL TEST: PORE PRESSURE
MONITORED DURING SHEAR

MRD Form 756, 1 May 80

PROJECT: CHASKA NCS-IA-82-126-ED-GH
BORING NO: 82-42 SAMPLE NO: 3
DEPTH/ELEV: 15.-16.5
MRD LAB NO: 65/67 DATE: 08 MAR 1983

TRIAXIAL COMPRESSION TEST REPORT

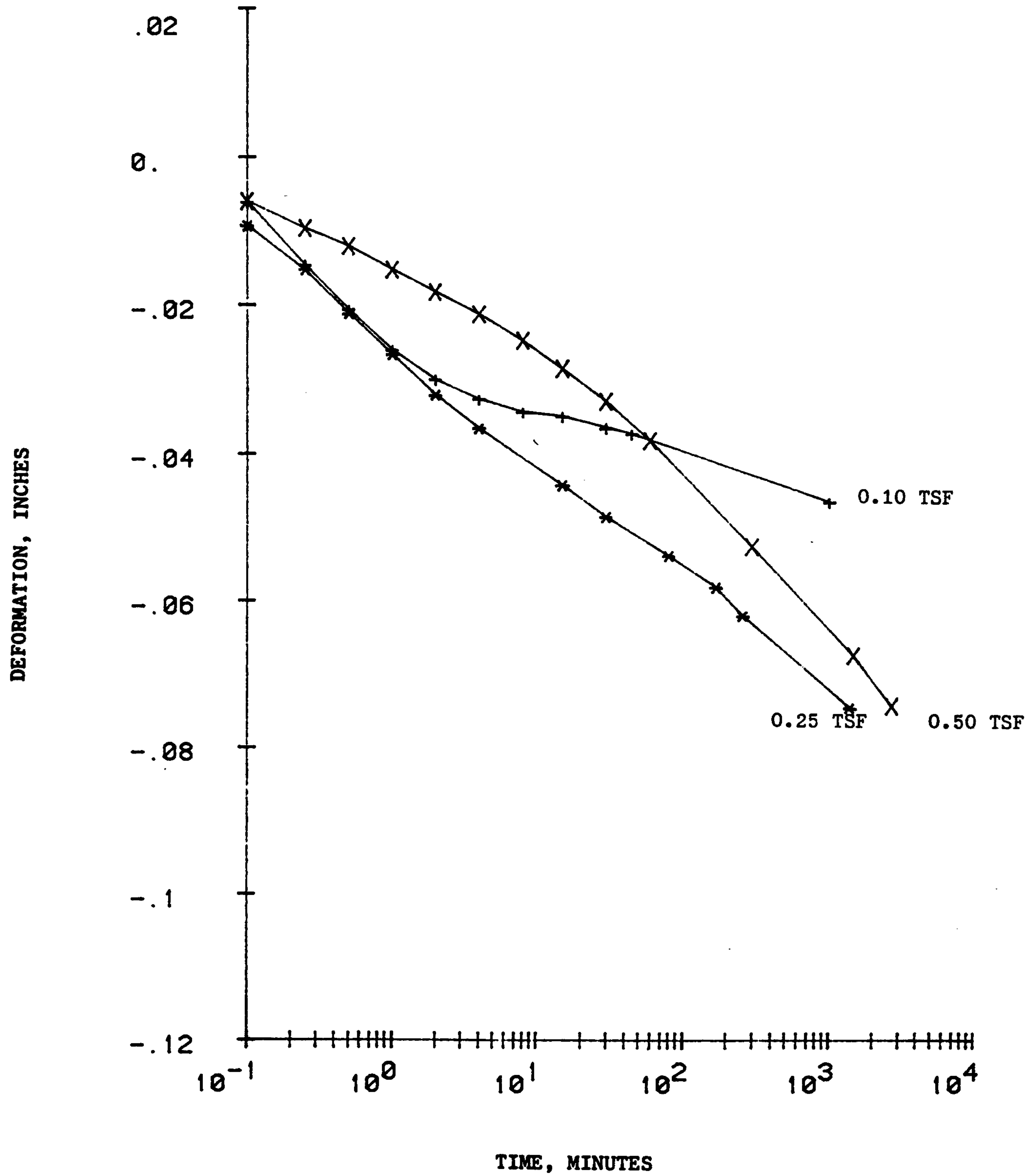
FIGURE: 7



Type of Specimen UNDISTURBED		Before Test		After Test		
Diam 4.29 in.	Ht .998 in.	Water Content, w_o	253. %	w_f	161. %	
Overburden Pressure, Po T/sq ft		Void Ratio, e_o	5.45	e_f	3.21	
Preconsol. Pressure, Pc T/sq ft		Saturation, S_o	100. %	S_f	100. %	
Compression Index, C_c		Dry Density, γ_d	21.2 lb/ft^3			
Classification Sandy organic clay, OH		k_{20} at e_o = × 10^{-} cm/sec				
LL 212	G_s 2.19	Project CHASKA NCS-IA-82-126-ED-GH				
PL 125	D_{10}					
Remarks Note the secondary consolidation.		Area MRD LAB NO: 83/67				
		Boring No. 82-42MU		Sample No. 3		
		Depth El 15.0-16.3		Date 24 MAR 1983		
		CONSOLIDATION TEST REPORT				

ENG FORM 1 MAY 63 2090 PREVIOUS EDITIONS ARE OBSOLETE.

Figure 5



PROJECT: CHASKA NCS-IA-82-126-ED-GH

MRD LAB NO: 83/67 DATE: 24 MAR 1983

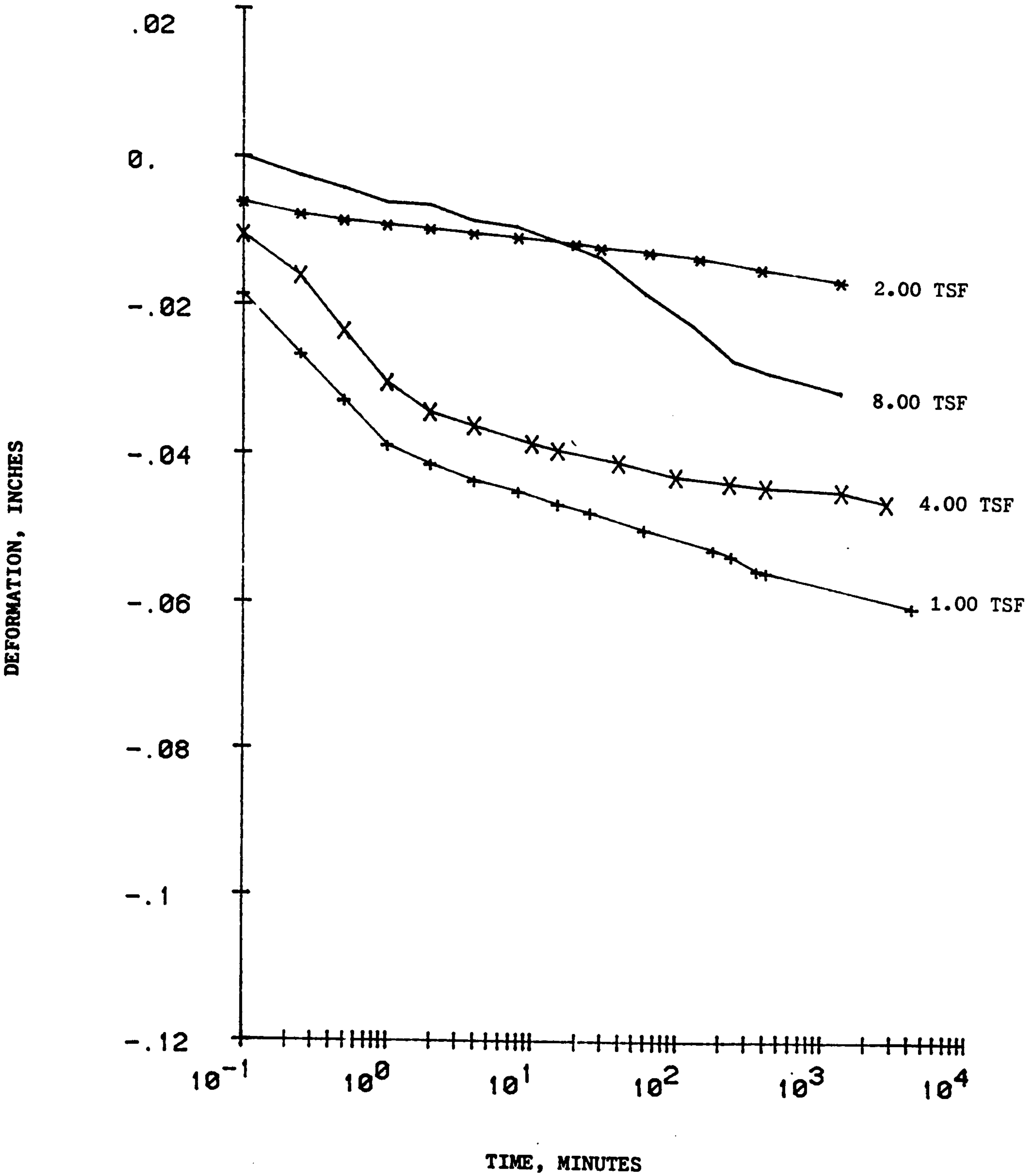
BORING NO: 82-42MU SAMPLE NO: 3 DEPTH/ELEV: 15.0-16.3

CONSOLIDATION TEST--TIME CURVES

COMPUTER PRINT-OUT FORMAT
SAME AS ENG FORM 2088

FIGURE: 6

MRD Form 956, 1 May 80



PROJECT: CHASKA NCS-IA-82-126-ED-GH

MRD LAB NO: 83/67

DATE: 24 MAR 1983

BORING NO: 82-42MU

SAMPLE NO: 3

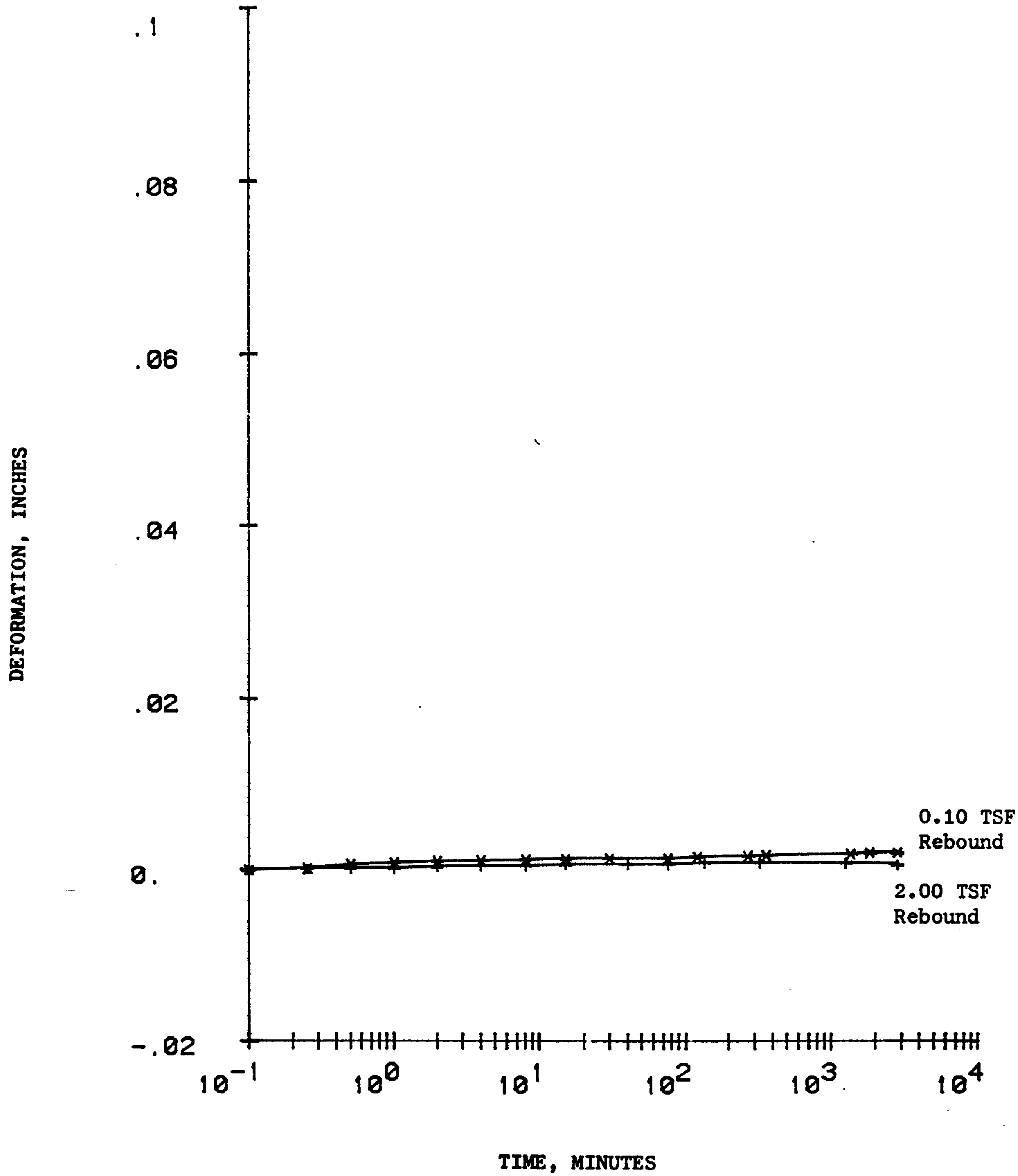
DEPTH/ELEV: 15.8-16.3

COMPUTER PRINT-OUT FORMAT
SAME AS ENG FORM 2088

CONSOLIDATION TEST—TIME CURVES

FIGURE: 7

RD Form 956, 1 May 80



PROJECT: CHASKA NCS-IA-82-126-ED-GH

MRD LAB NO: 83/67

DATE: 24 MAR 1983

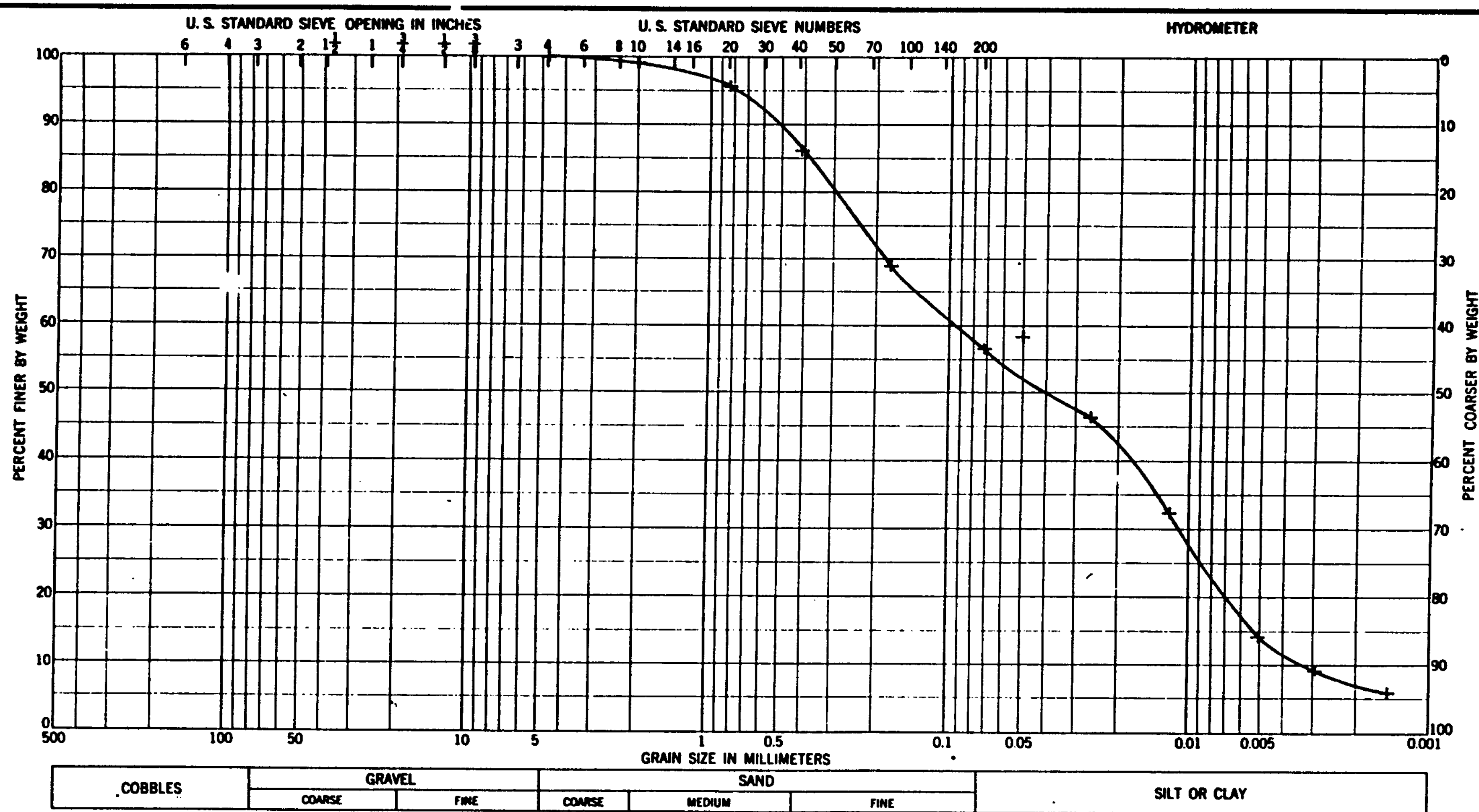
BORING NO: 82-42MU SAMPLE NO: 3

DEPTH/ELEV: 15.0-16.3

CONSOLIDATION TEST—TIME CURVES

COMPUTER PRINT-OUT FORMAT
SAME AS ENG FORM 2088

FIGURE: 8



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
3	15.-16.3	Sandy organic clay, OH		212	87	125

Project CHASKA NCS-IA-82-126-ED-GH

Area MRD LAB NO. 83/67

Boring No. 82-42

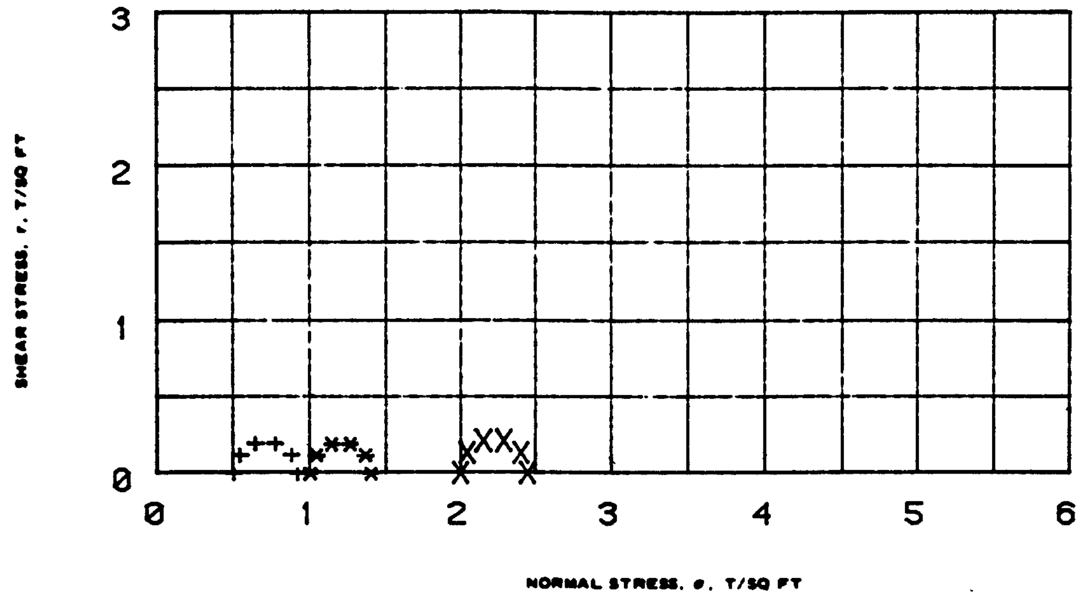
Date 08 MAR 1983

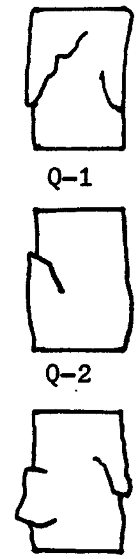
GRADATION CURVES

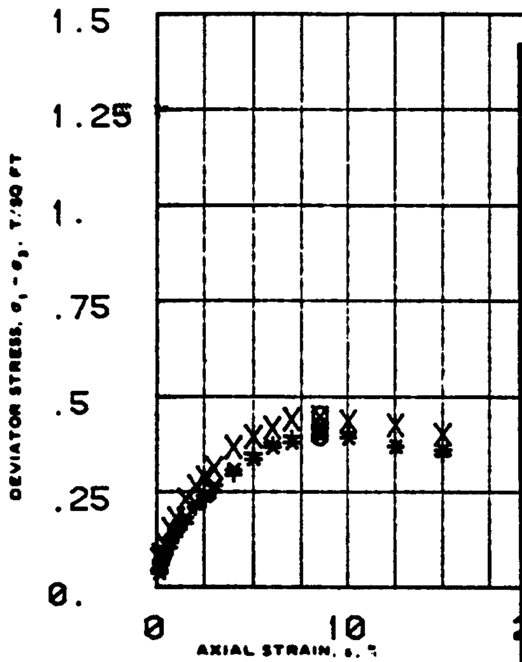
ENG FORM 1 MAY 63 2087

FIGURE 8

35







SPECIMEN NO.			1	2	3	
INITIAL	WATER CONTENT, %	w_o	81.4	88.1	87.6	
	DRY DENSITY LB/CU FT	γd_o	51.5	47.3	48.5	
	SATURATION, %	S_o	100.	97.	99.	
	VOID RATIO	e_o	1.95	2.21	2.14	
BEFORE SHEAR	WATER CONTENT, %	w_c	81.4	88.	87.4	
	DRY DENSITY LB/CU FT	γd_c	51.5	47.3	48.4	
	SATURATION, %	S_c	100.	97.	99.	
	VOID RATIO	e_c	1.95	2.21	2.14	
	FINAL BACK PRESSURE, T/SQ FT	u_o	0.	0.	0.	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.5	1.	2.	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	.415	.481	.444	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	18	18	18	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	.35	.382	.402	
INITIAL DIAMETER, IN.		D_o	1.4	1.4	1.4	
INITIAL HEIGHT, IN.		H_o	3.00	3.00	3.00	

CONTROLLED- TEST

DESCRIPTION OF SPECIMENS Peat, OH

LL 115	PL 47	PI 68	Gs 2.45	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST Q

REMARKS: Mottled gray-black, soft consistency, low strength at PL, dull shine, medium shake response. highly calcareous, slight organic odor, shells throughout.

PROJECT CHASKA NCS-IA-82-128-ED-GH

BORING NO. 82-42

SAMPLE NO. 5

DEPTH ELEV 25-28.4

LABORATORY 83/87

DATE 08 MAR 1983

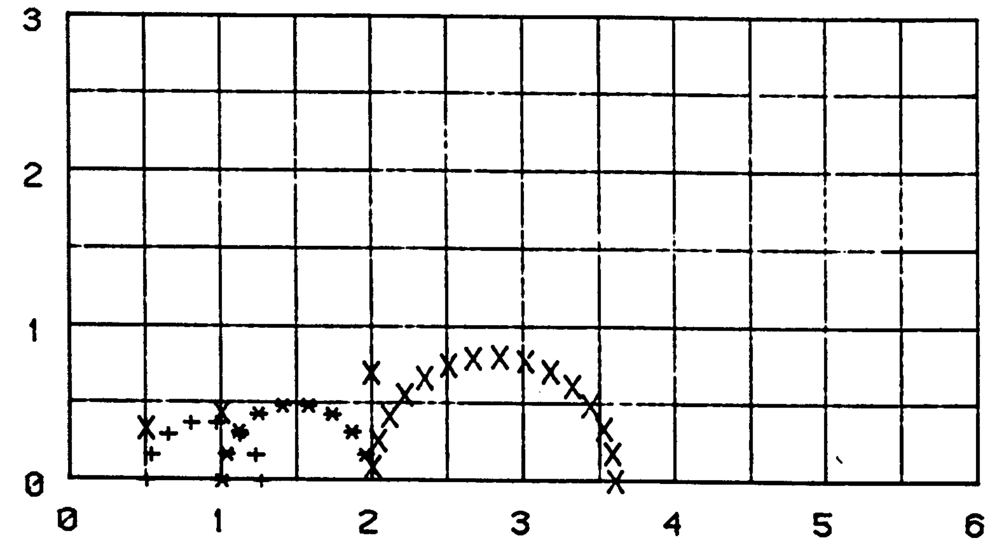
TRIAXIAL COMPRESSION TEST REPORT

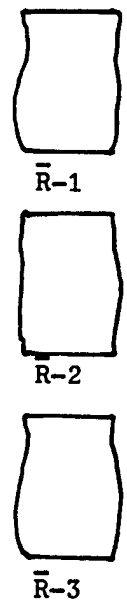
ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

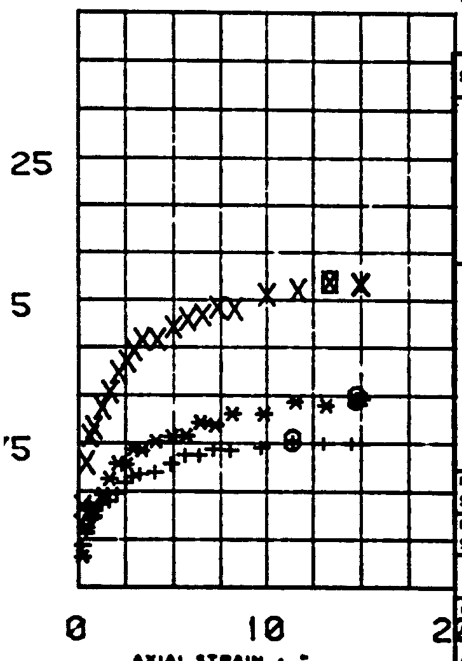
Figure 9

Figure D-37

FIGURE







SPECIMEN NO.			1	2	3
INITIAL	WATER CONTENT, %	w_o	50.1	49.6	48.8
	DRY DENSITY LB/CU FT	γd_o	70.9	71.7	72.1
	SATURATION, %	S_o	100.	100.	100.
	VOID RATIO	e_o	1.14	1.11	1.1
BEFORE SHEAR	WATER CONTENT, %	w_c	44.2	40.2	36.5
	DRY DENSITY LB/CU FT	γd_c	74.4	77.5	82.7
	SATURATION, %	S_c	100.	100.	100.
	VOID RATIO	e_c	1.04	.96	.83
	FINAL BACK PRESSURE, T/SQ FT	u_o	1.9	1.9	1.9
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.5	1.	2.
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	.764	.99	1.6
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	900	1200	1000
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	.756	.989	1.58
INITIAL DIAMETER, IN.		D_o	1.4	1.4	1.39
INITIAL HEIGHT, IN.		H_o	3.	2.99	3.

-LLED- STRAIN TEST

-TION OF SPECIMENS Peat, OH B value = 1.00 0.98 1.00

	PL 47	PI 68	Gs 2.45	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST R̄

PROJECT CHASKA NCS-IA-82-128-FD-GH

BORING NO 82-42 SAMPLE NO. 5

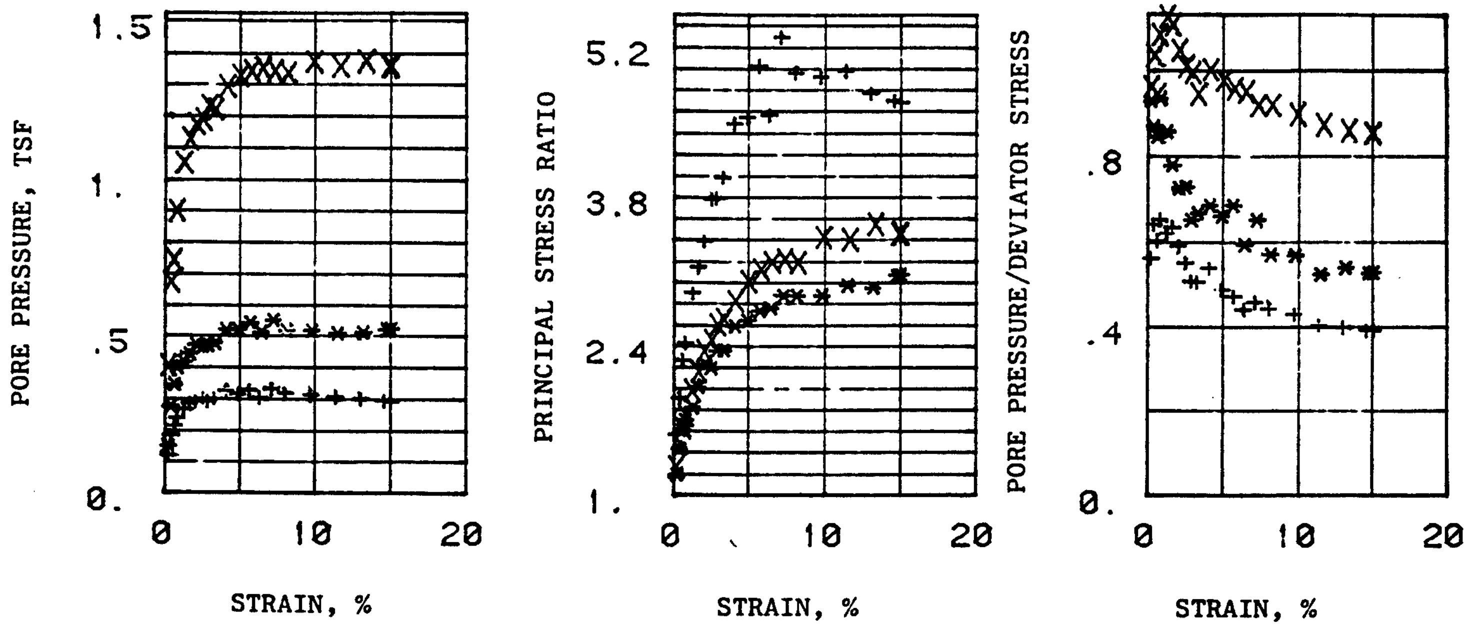
DEPTH ELEV 25-26.4

LABORATORY 86/87 DATE 08 MAR 1983

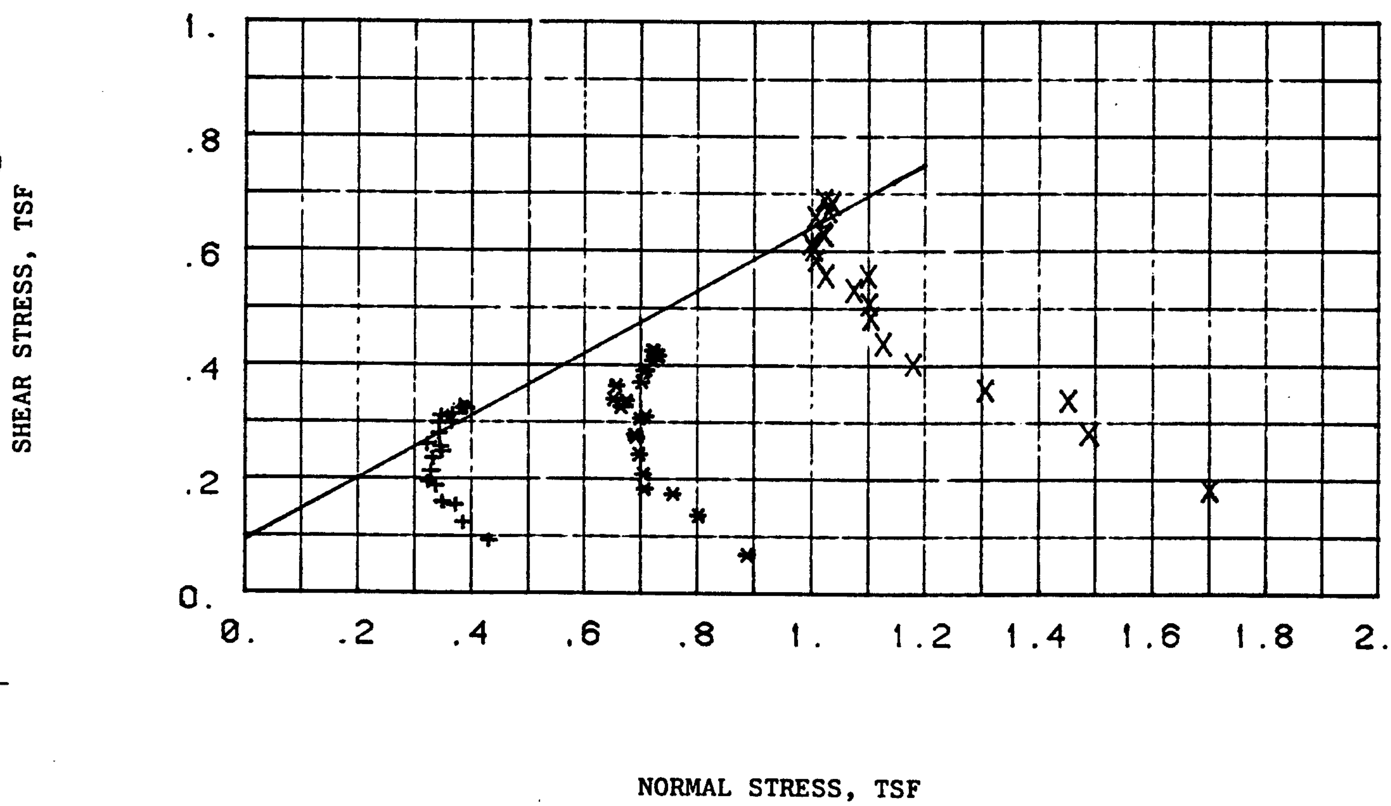
TRIAXIAL COMPRESSION TEST REPORT

-NO. 2089 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT *(EM 1110-2-1906)*

Figure 10



EFFECTIVE STRESS VECTOR CURVES ON 60.DEGREE PLANE



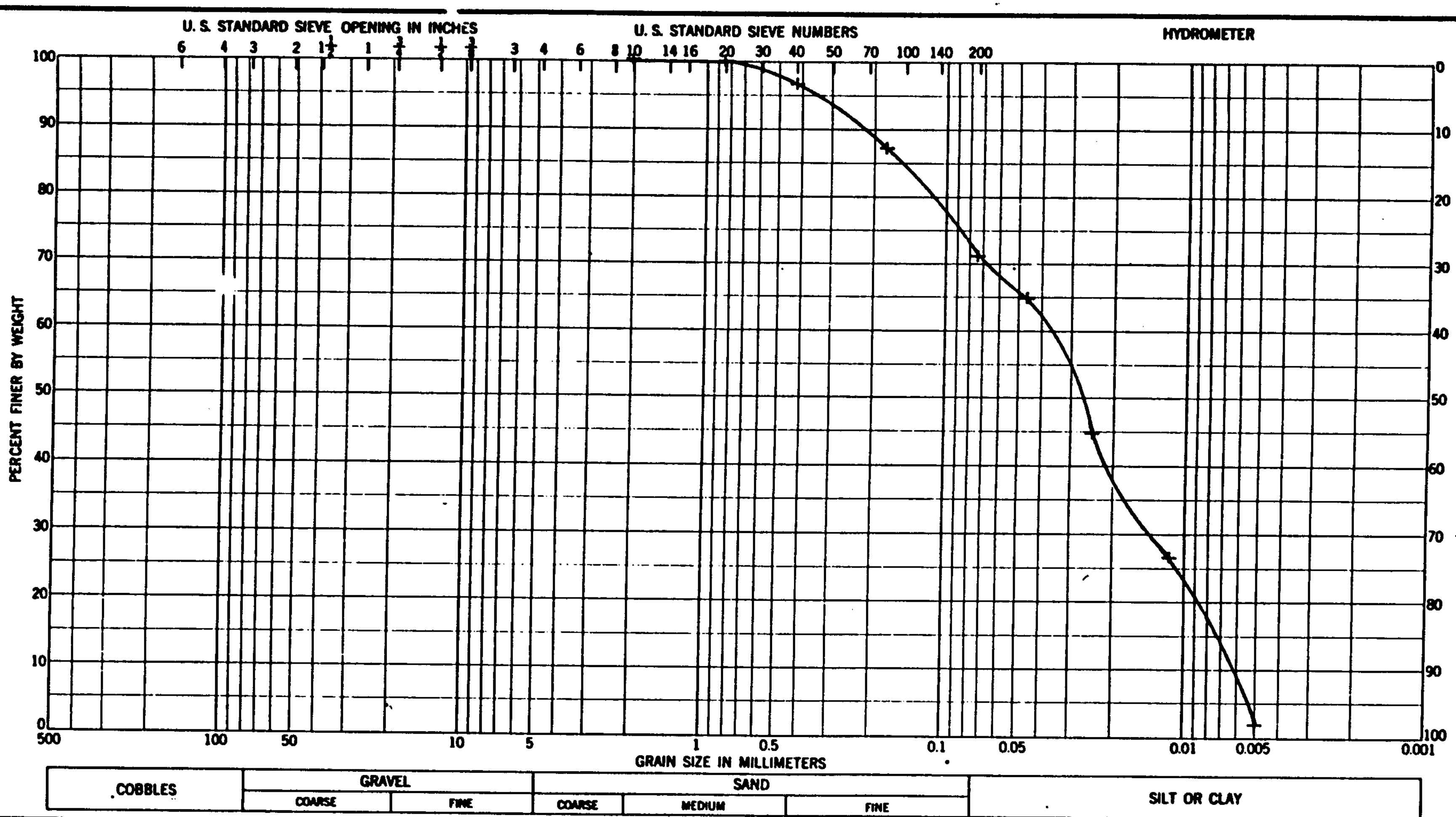
REMARKS: COMPUTER PRINT-OUT
SYMBOLS SAME AS FORM 2089
R̄ TRIAXIAL TEST: PORE PRESSURE
MONITORED DURING SHEAR

PROJECT:	CHASKA NCS-IA-82-126-ED-BN		
BORING NO:	82-42	SAMPLE NO:	5
DEPTH/ELEV:	25-26.4		
MRD LAB NO:	85/87	DATE:	08 MAR 1983

TRIAXIAL COMPRESSION TEST REPORT

FIGURE: 11

MRD Form 756, 1 May 80



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
5	25.-26.4	Peat, OH		115	47	68

Project CHASKA NCS-IA-82-126-ED-GH

Area MRD LAB NO. 83/67

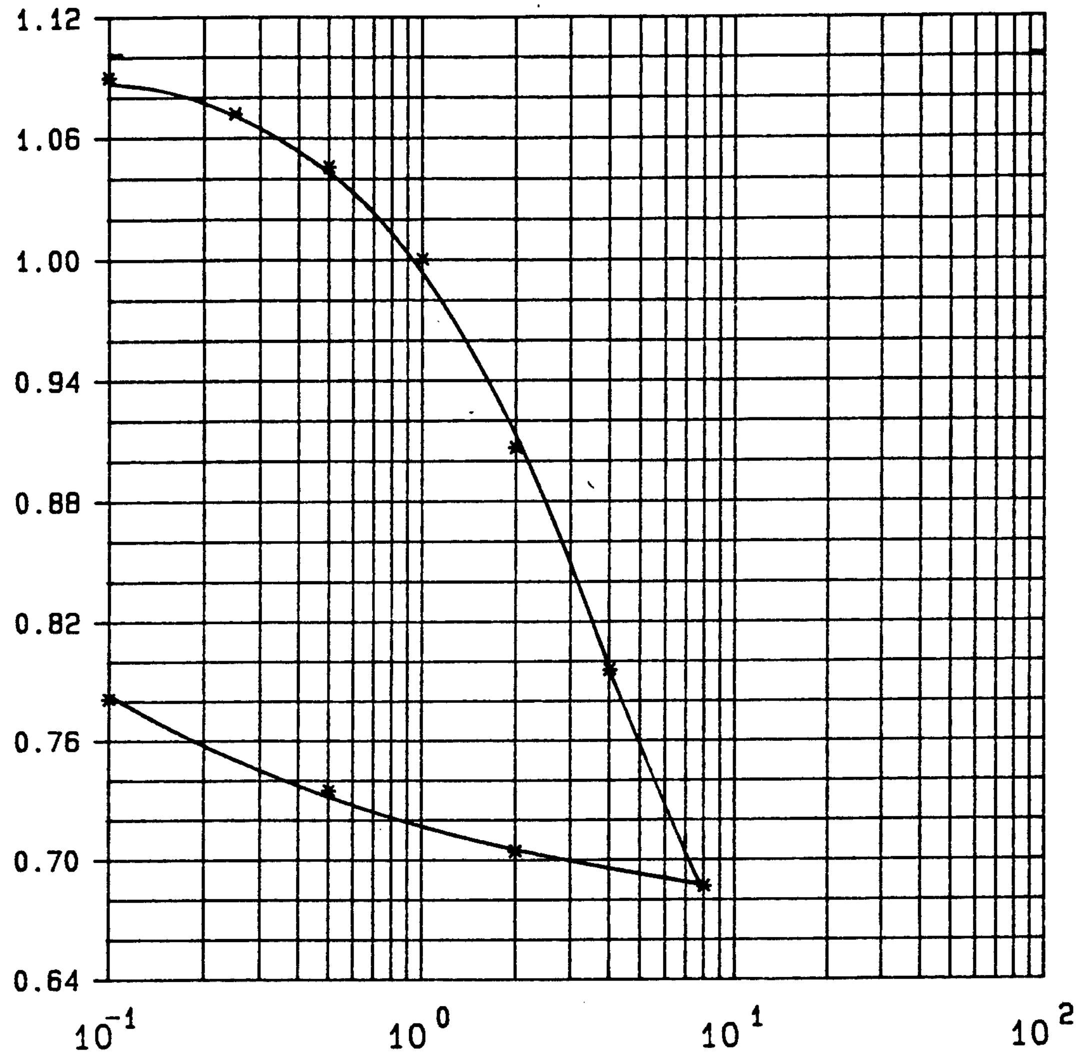
Boring No. 82-42

Date 08 MAR 1983

GRADATION CURVES

ENG FORM 1 MAY 63 2087

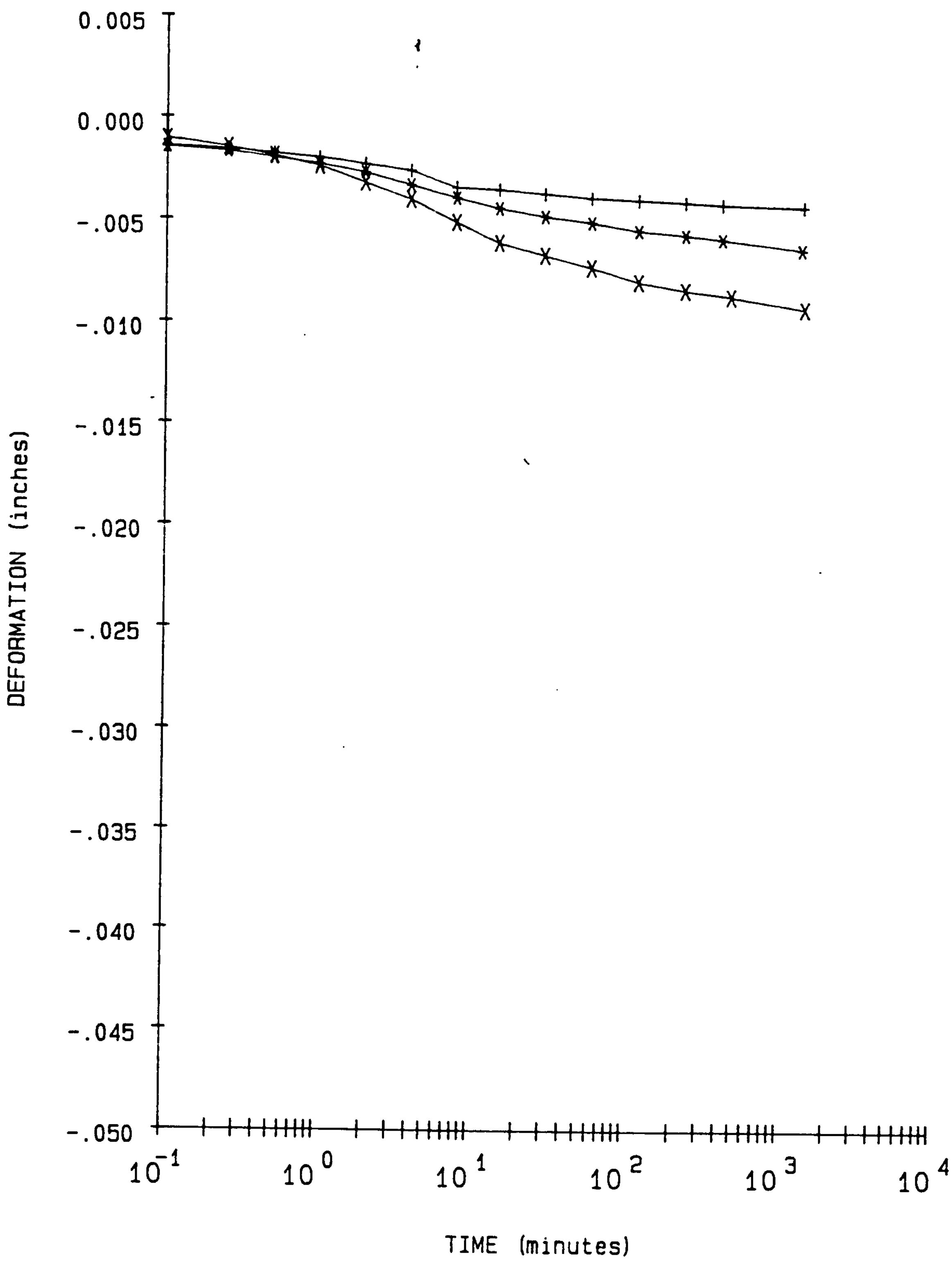
FIGURE 12



Type of Specimen UNDISTURBED		Before Test		After Test	
Diam 2.5 in.	Ht .75 in.	Water Content, w_o	34.5 %	w_f	35.7 %
Overburden Pressure, p_o T/sq ft		Void Ratio, e_o	1.10	e_f	0.78
Preconsol. Pressure, p_c T/sq ft		Saturation, S_o	90 %	S_f	100 %
Compression Index, C_c		Dry Density, γ_d	85.5 lb/ft^3		
Classification Sandy clay, CH		k_{20} at e_o = x 10^{-} cm/sec			
LL 55	G_s 2.88	Project CHASKA; CENCS-IA-90-78-ED-GH			
PL 19	D_{10}				
Remarks Black. Torvane = 0.325 TSF. Slightly organic, non-calcareous.		Area MRD LAB NO. 90/358			
		Boring No. 90-132 MU		Sample No. S-1	
		Depth El 14'-16'		Date 07-16-90	
		CONSOLIDATION TEST REPORT			

ENG FORM 1 MAY 63 2090 PREVIOUS EDITIONS ARE OBSOLETE.

Figure 1



LEGEND

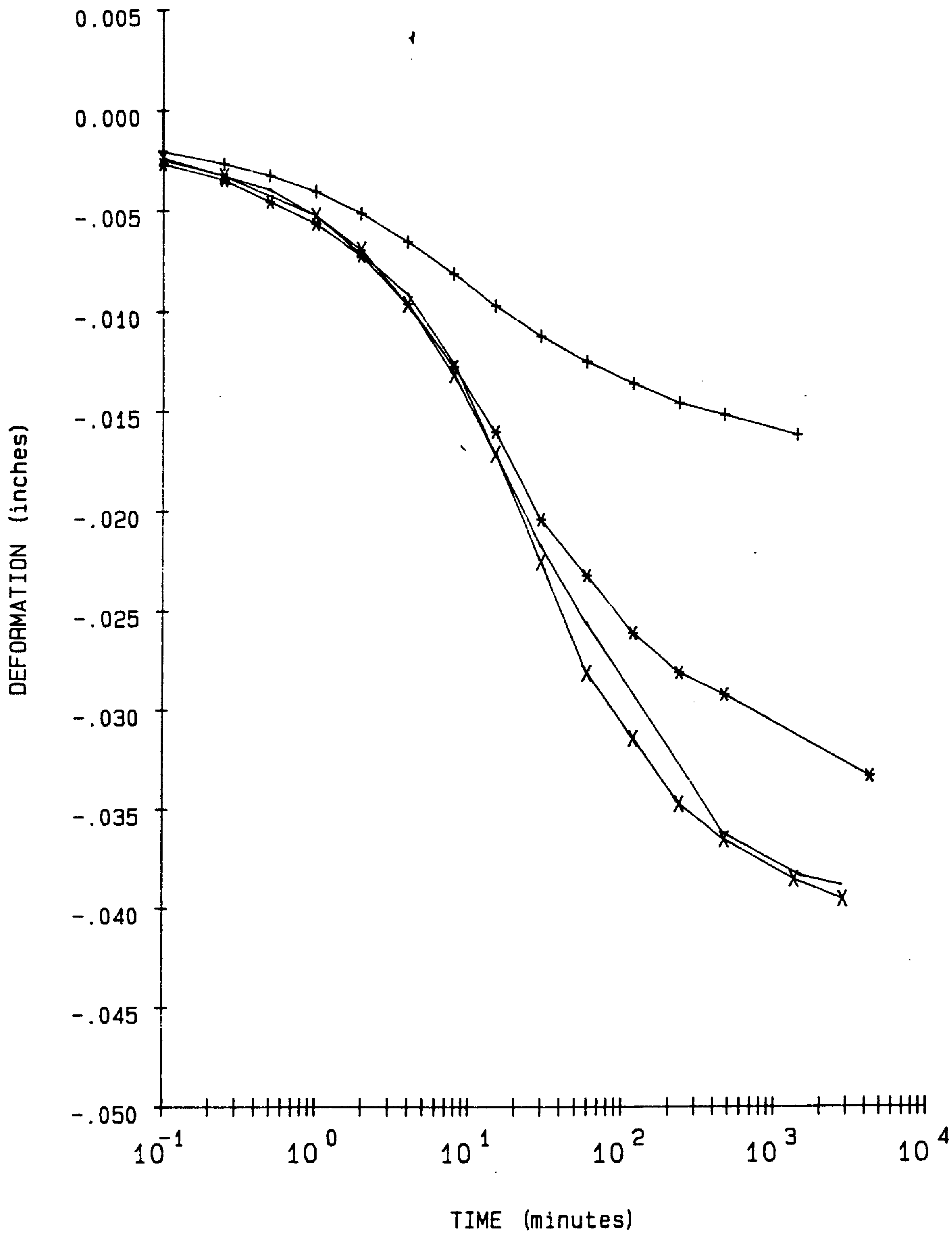
+ = .1 TSF Wet

* = .25 TSF

X = .5 TSF

PROJECT	CHASKA: CENCS-IA-90-78-ED-GH
BORING NO.	90-132 MU
SAMPLE NO.	S-1
DEPTH/ELEV	14'-16'
MRD LAB NO.	90/358

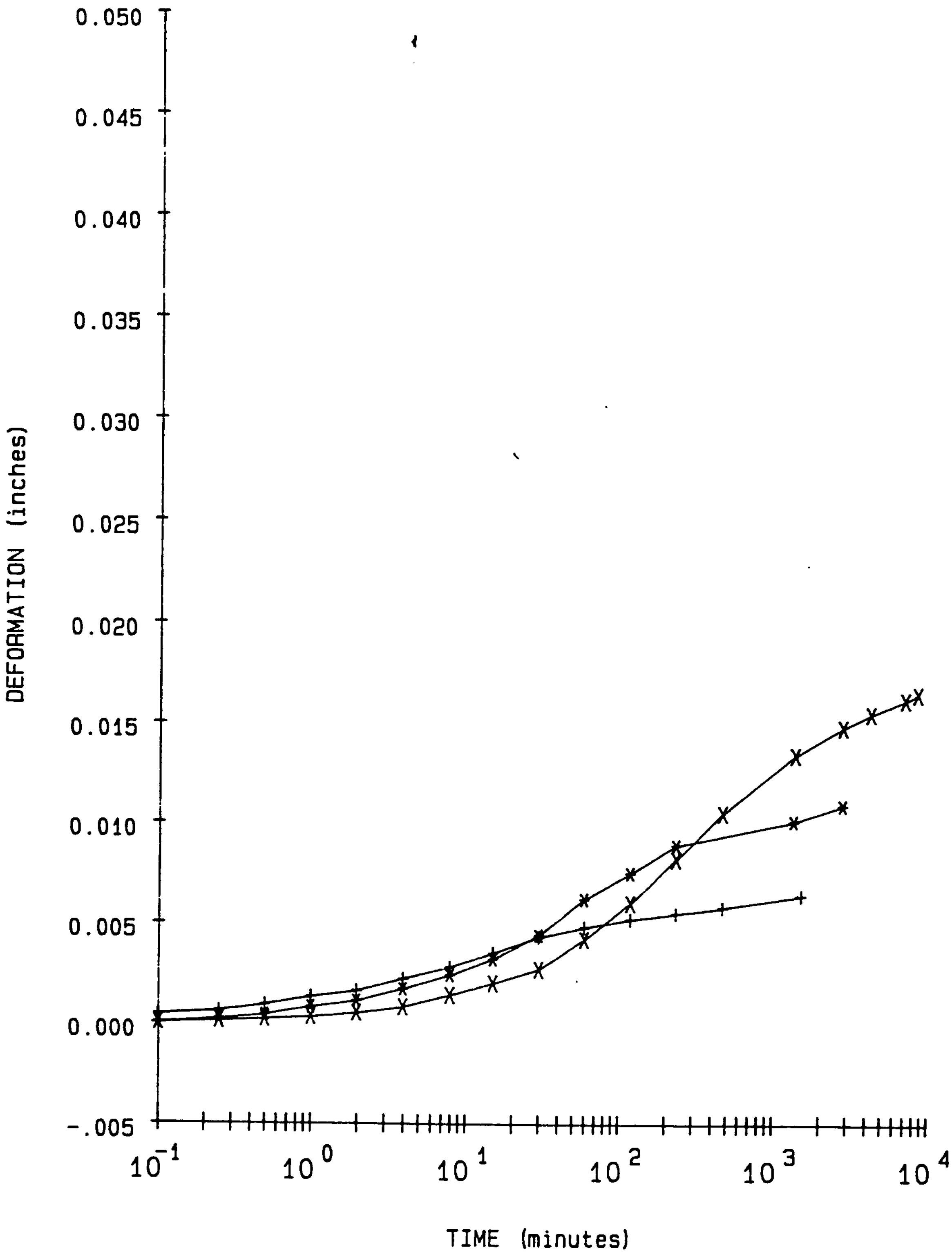
FIGURE 2



LEGEND	
+ = 1	TSF
* = 2	TSF
X = 4	TSF
- = 8	TSF

PROJECT	CHASKA: CENCS-IA-90-78-ED-GH
BORING NO.	90-132 MU
SAMPLE NO.	S-1
DEPTH/ELEV	14'-16'
MRD LAB NO.	90/358

FIGURE 3



LEGEND

+ = 2 TSF Rebound

* = .5 TSF Rebound

X = .1 TSF Rebound

PROJECT	CHASKA: CENCS-IA-90-78-ED-GH
BORING NO.	90-132 MU
SAMPLE NO.	S-1
DEPTH/ELEV	14'-16'
MRD LAB NO.	90/358

FIGURE 4

FIGURE D-44

Consolidation Test Data

Project CHASKA; CENCS-IA-90-78-ED-GH

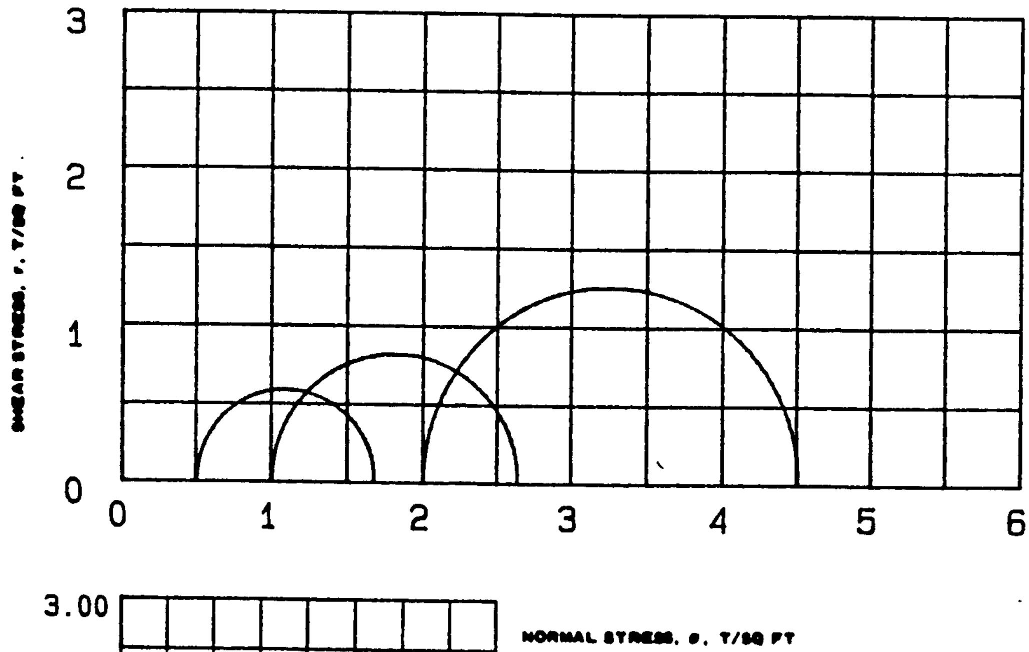
Boring No. 90-132 MU
Sample No. S-1
Depth/Elev 14'-16'
MRD Lab No. 90/358

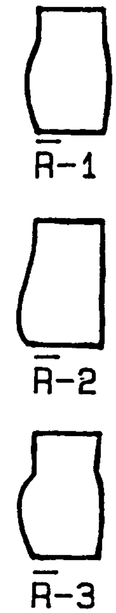
Gs = 2.88
eo = 1.102
0.42eo = 0.463

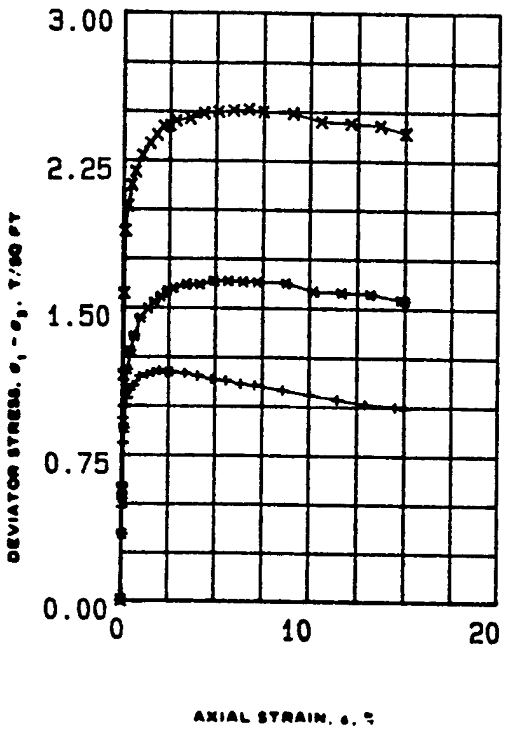
Water Content (%)	Dry Weight (gms)	Dry Density (PCF)	Void Ratio	Pressure (TSF)	Saturation (%)
34.5	82.7	85.5	1.102		90.2
35.7	82.7	86.0	1.090	0.10	94.4
35.7	82.7	86.7	1.072	0.25	95.9
35.7	82.7	87.9	1.046	0.50	98.3
35.7	82.7	89.9	1.000	1.00	100.0
35.7	82.7	94.3	0.906	2.00	100.0
35.7	82.7	100.1	0.795	4.00	100.0
35.7	82.7	106.6	0.686	8.00	100.0
35.7	82.7	105.4	0.704	2.00	100.0
35.7	82.7	103.6	0.735	0.50	100.0
35.7	82.7	100.9	0.781	0.10	100.0

Axial Strain (%)	Void Ratio
1	1.081
2	1.060
3	1.039
4	1.018
5	0.997
6	0.976
7	0.955
8	0.933
9	0.912
10	0.891
11	0.870
12	0.849
13	0.828
14	0.807
15	0.786
16	0.765
17	0.744
18	0.723
19	0.702
20	0.681

FIGURE D-45







			1 (+)	2 (*)	3 (X)	
SPECIMEN NO.			1 (+)	2 (*)	3 (X)	
INITIAL	WATER CONTENT, %	w_o	34.2	33.1	25.6	
INITIAL	DRY DENSITY LB/CU FT	γd_o	84.7	86.1	101.7	
INITIAL	SATURATION, %	S_o	88	88	96	
INITIAL	VOID RATIO	e_o	1.12	1.09	.77	
BEFORE SHEAR	WATER CONTENT, %	w_c	32.7	29	19.9	
BEFORE SHEAR	DRY DENSITY LB/CU FT	γd_c	93.3	99.3	116.1	
BEFORE SHEAR	SATURATION, %	S_c	100	100	100	
BEFORE SHEAR	VOID RATIO	e_c	.93	.81	.55	
BEFORE SHEAR	FINAL BACK PRESSURE, T/SQ FT	u_o	5.543	5.543	5.543	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.5	1	2	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	1.178	1.638	2.510	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	300	600	840	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	0.990	1.539	2.390	
INITIAL DIAMETER, IN.		D_o	1.44	1.42	1.39	
INITIAL HEIGHT, IN.		H_o	3	2.99	2.88	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Sandy clay, CH B-Value 1.0 1.0 1.0

LL 55	PL 19	PI 36	G_s 2.88	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST RBAR

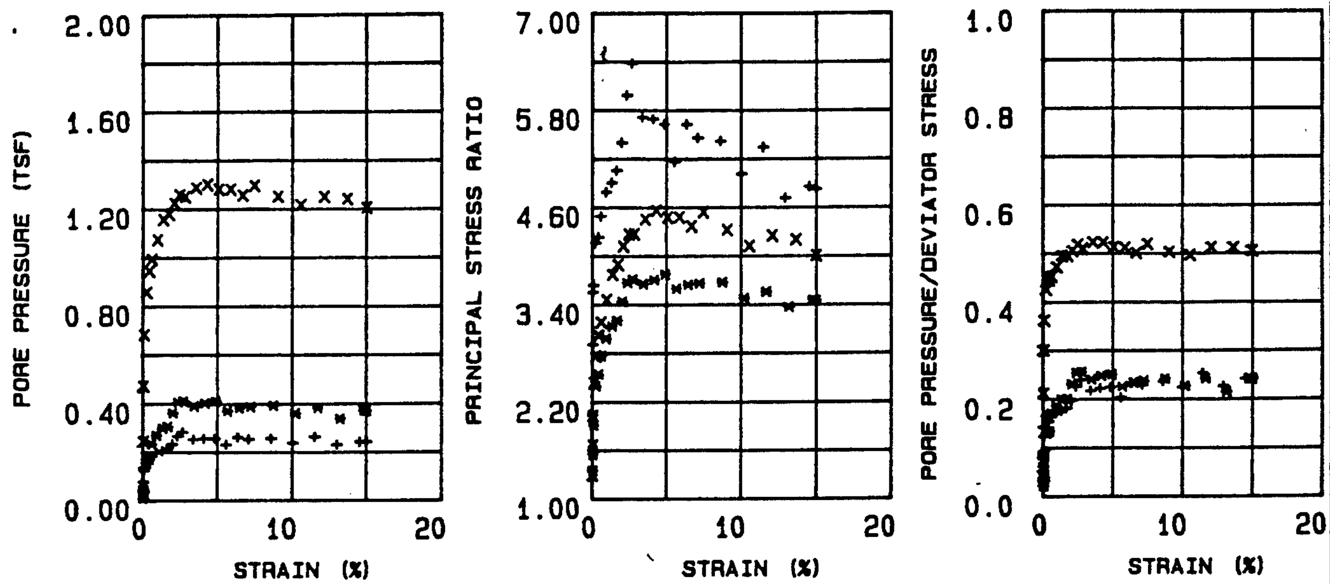
REMARKS: Black. Torvane = 0.325 TSF.
Slightly organic, non-calcareous.

PROJECT	CHASKA; CENCS-IA-90-78-ED-GH
BORING NO. 90-132 MU	SAMPLE NO. S-1
DEPTH ELEV 14'-16'	
LABORATORY 90/358	DATE 07-10-90

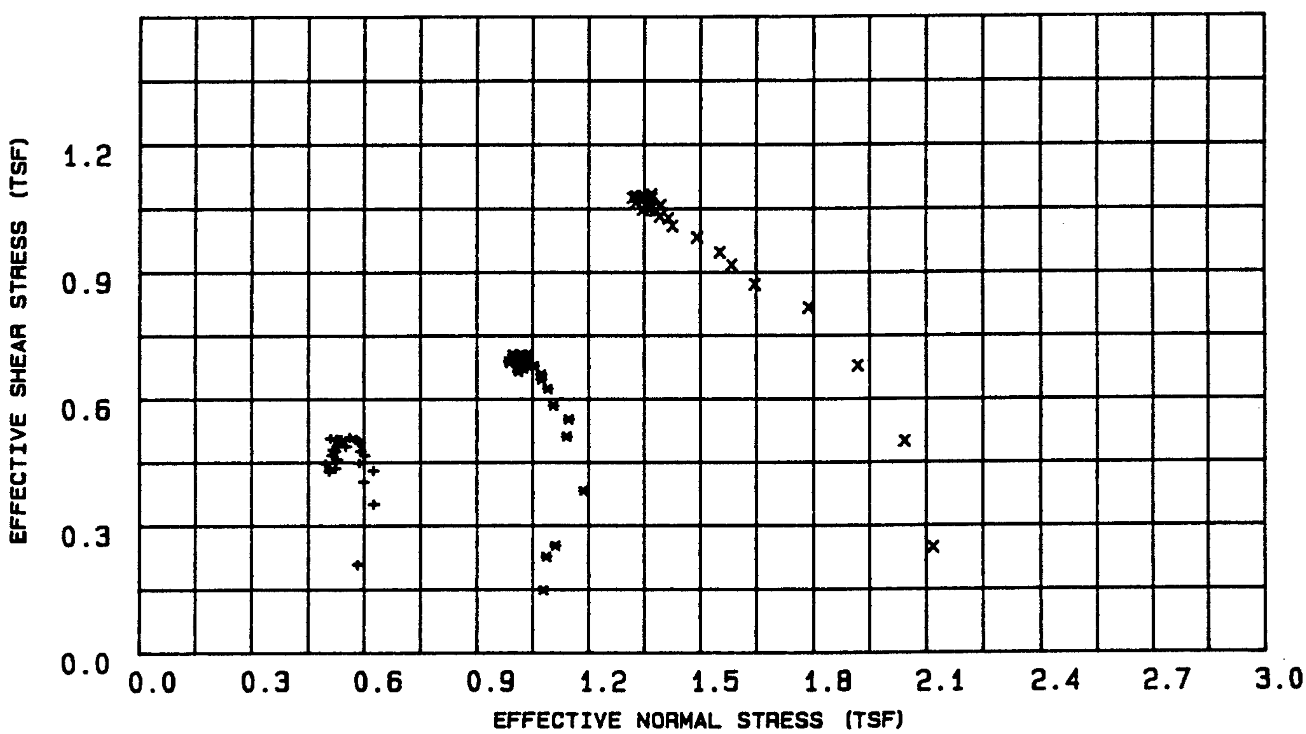
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

FIGURE 5



EFFECTIVE STRESS VECTOR CURVES ON 60 DEGREE PLANE



LEGEND

+ = .5 TSF
* = 1 TSF
X = 2 TSF

PROJECT	CHASKA: CENCS-IA-90-78-ED-GH
BORING NO.	90-132 MU
SAMPLE NO.	S-1
DEPTH/ELEV	14'-16'
MRD LAB NO.	90/358

FIGURE 6

Table 1 - Triaxial $\bar{R}$ Test Results

Project : CHASKA; CENCS-IA-90-78-ED-GH
Boring Number : 90-132 MU
Sample Number : S-1
Depth : 14'-16'
Confining Pressure : .5 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.05	0.481	0.037	2.039	0.078	0.582	0.208
30	0.07	0.810	0.075	2.904	0.092	0.626	0.350
45	0.07	0.935	0.133	3.548	0.143	0.598	0.403
60	0.12	0.996	0.122	3.638	0.123	0.625	0.430
90	0.26	1.038	0.171	4.158	0.166	0.586	0.448
120	0.44	1.079	0.166	4.231	0.154	0.601	0.466
150	0.61	1.102	0.184	4.489	0.168	0.589	0.476
180	0.95	1.148	0.197	4.788	0.172	0.587	0.496
210	1.33	1.158	0.203	4.902	0.176	0.584	0.500
240	1.67	1.168	0.212	5.053	0.182	0.577	0.504
300	2.01	1.178	0.232	5.397	0.197	0.560	0.509
360	2.35	1.171	0.265	5.984	0.227	0.525	0.505
420	2.69	1.172	0.282	6.380	0.241	0.508	0.506
480	3.39	1.166	0.252	5.706	0.217	0.537	0.503
540	4.09	1.151	0.254	5.686	0.222	0.531	0.497
600	4.82	1.135	0.254	5.622	0.225	0.527	0.490
720	5.57	1.128	0.229	5.158	0.203	0.550	0.487
840	6.35	1.111	0.260	5.623	0.234	0.515	0.479
960	7.10	1.103	0.252	5.453	0.229	0.521	0.476
080	8.60	1.079	0.255	5.412	0.237	0.512	0.466
200	10.03	1.056	0.236	5.006	0.224	0.526	0.456
320	11.48	1.033	0.262	5.338	0.254	0.494	0.446
440	12.96	1.009	0.228	4.707	0.226	0.522	0.435
560	14.53	0.998	0.241	4.848	0.242	0.506	0.431
596	15.00	0.990	0.241	4.817	0.244	0.504	0.427

Table 2 - Triaxial $\overline{R}$ Test Results

Project : CHASKA; CENCS-IA-90-78-ED-GH
Boring Number : 90-132 MU
Sample Number : S-1
Depth : 14'-16'
Confining Pressure : 1 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.05	0.343	0.007	1.345	0.021	1.078	0.148
30	0.07	0.523	0.044	1.547	0.085	1.086	0.226
45	0.07	0.584	0.035	1.605	0.061	1.110	0.252
60	0.12	0.884	0.033	1.915	0.038	1.186	0.382
90	0.27	1.183	0.153	2.397	0.130	1.140	0.511
120	0.44	1.279	0.171	2.542	0.134	1.146	0.552
150	0.62	1.355	0.232	2.765	0.172	1.104	0.585
180	0.96	1.447	0.269	2.980	0.187	1.089	0.624
210	1.36	1.497	0.299	3.135	0.200	1.072	0.646
240	1.70	1.528	0.306	3.202	0.201	1.072	0.659
300	2.05	1.558	0.361	3.437	0.232	1.025	0.673
360	2.39	1.589	0.405	3.668	0.255	0.988	0.686
420	2.74	1.599	0.410	3.710	0.257	0.986	0.690
480	3.45	1.619	0.389	3.649	0.241	1.012	0.699
540	4.17	1.619	0.401	3.704	0.248	1.000	0.699
600	4.91	1.638	0.410	3.775	0.251	0.996	0.707
720	5.67	1.636	0.369	3.594	0.226	1.036	0.706
[illegible]40	6.46	1.633	0.382	3.642	0.234	1.022	0.705
[illegible]60	7.22	1.631	0.387	3.660	0.238	1.017	0.704
1080	8.75	1.625	0.392	3.674	0.242	1.010	0.701
1200	10.21	1.585	0.359	3.472	0.227	1.033	0.684
1320	11.69	1.579	0.382	3.554	0.242	1.009	0.681
1440	13.19	1.571	0.336	3.366	0.214	1.053	0.678
1560	14.79	1.543	0.371	3.454	0.241	1.011	0.666
1575	15.00	1.539	0.370	3.443	0.241	1.011	0.664

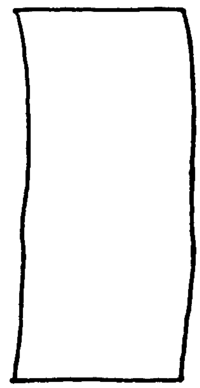
Table 3 - Triaxial $\bar{R}$ Test Results

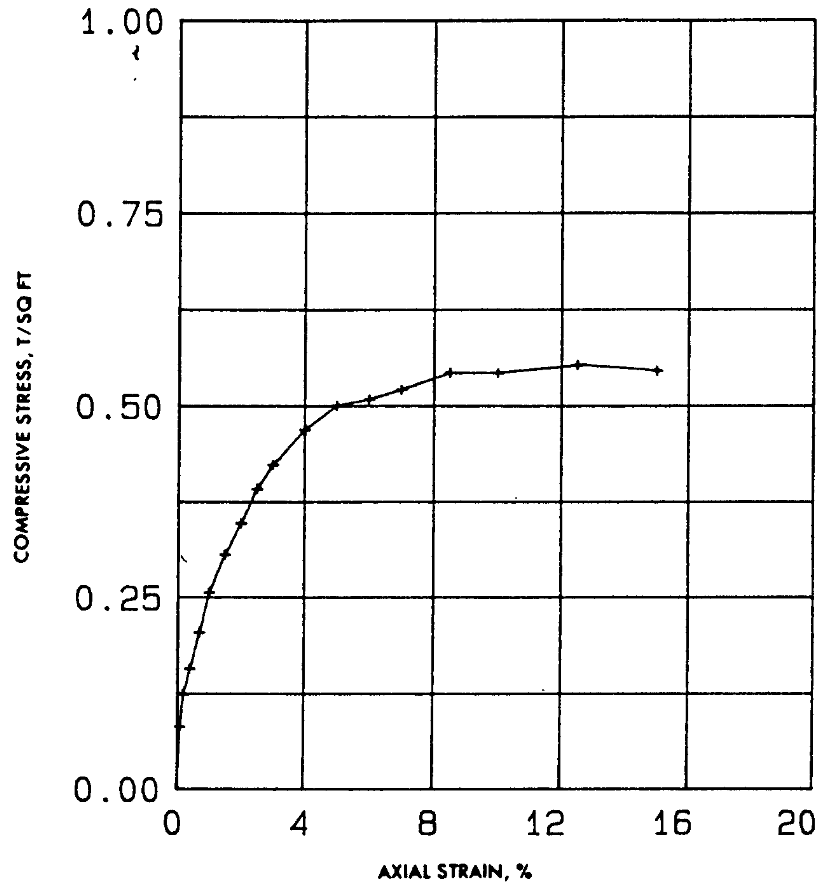
Project : CHASKA; CENCS-IA-90-78-ED-GH
Boring Number : 90-132 MU
Sample Number : S-1
Depth : 14'-16'
Confining Pressure : 2 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.05	0.572	0.024	1.290	0.042	2.118	0.247
30	0.08	1.156	0.244	1.659	0.212	2.042	0.499
45	0.08	1.571	0.471	2.027	0.300	1.918	0.678
60	0.13	1.890	0.682	2.435	0.362	1.786	0.816
90	0.28	2.018	0.856	2.763	0.425	1.644	0.871
120	0.46	2.125	0.944	3.013	0.445	1.582	0.917
150	0.64	2.194	0.993	3.179	0.453	1.550	0.947
180	1.00	2.276	1.073	3.456	0.472	1.490	0.982
210	1.40	2.337	1.156	3.769	0.495	1.423	1.009
240	1.76	2.380	1.177	3.892	0.495	1.412	1.027
300	2.12	2.423	1.223	4.118	0.505	1.377	1.046
360	2.48	2.429	1.257	4.268	0.518	1.344	1.048
420	2.84	2.453	1.249	4.268	0.510	1.358	1.059
480	3.58	2.463	1.286	4.452	0.523	1.324	1.063
540	4.32	2.491	1.300	4.557	0.522	1.317	1.075
600	5.08	2.499	1.280	4.473	0.513	1.339	1.078
720	5.88	2.505	1.279	4.474	0.511	1.341	1.081
840	6.69	2.510	1.254	4.363	0.500	1.367	1.083
960	7.48	2.498	1.294	4.537	0.519	1.324	1.078
080	9.07	2.489	1.249	4.316	0.502	1.367	1.074
200	10.57	2.449	1.214	4.115	0.496	1.392	1.057
320	12.11	2.440	1.248	4.245	0.512	1.356	1.053
440	13.67	2.429	1.239	4.192	0.511	1.362	1.048
536	15.00	2.390	1.202	3.997	0.504	1.389	1.031
536	15.00	2.390	1.202	3.997	0.504	1.389	1.031

4[?]

FAILURE SKETCHES





☐ CONTROLLED STRESS

☒ CONTROLLED STRAIN

TEST NO.						
TYPE OF SPECIMEN UNDISTURBED						
INITIAL	WATER CONTENT	w_o	37.0 %	%	%	%
	VOID RATIO	e_o	1.04			
	SATURATION	S_o	96 %	%	%	%
	DRY DENSITY, LB/CU FT	γ_d	82.8			
TIME TO FAILURE, MIN		t_f	27.8			
UNCONFINED COMPRESSIVE STRENGTH, T/SQ FT		q_u	0.55			
UNDRAINED SHEAR STRENGTH, T/SQ FT		s_u				
SENSITIVITY RATIO		S_t				
INITIAL SPECIMEN DIAMETER, IN		D_o	1.38			
INITIAL SPECIMEN HEIGHT, IN.		H_o	2.99			

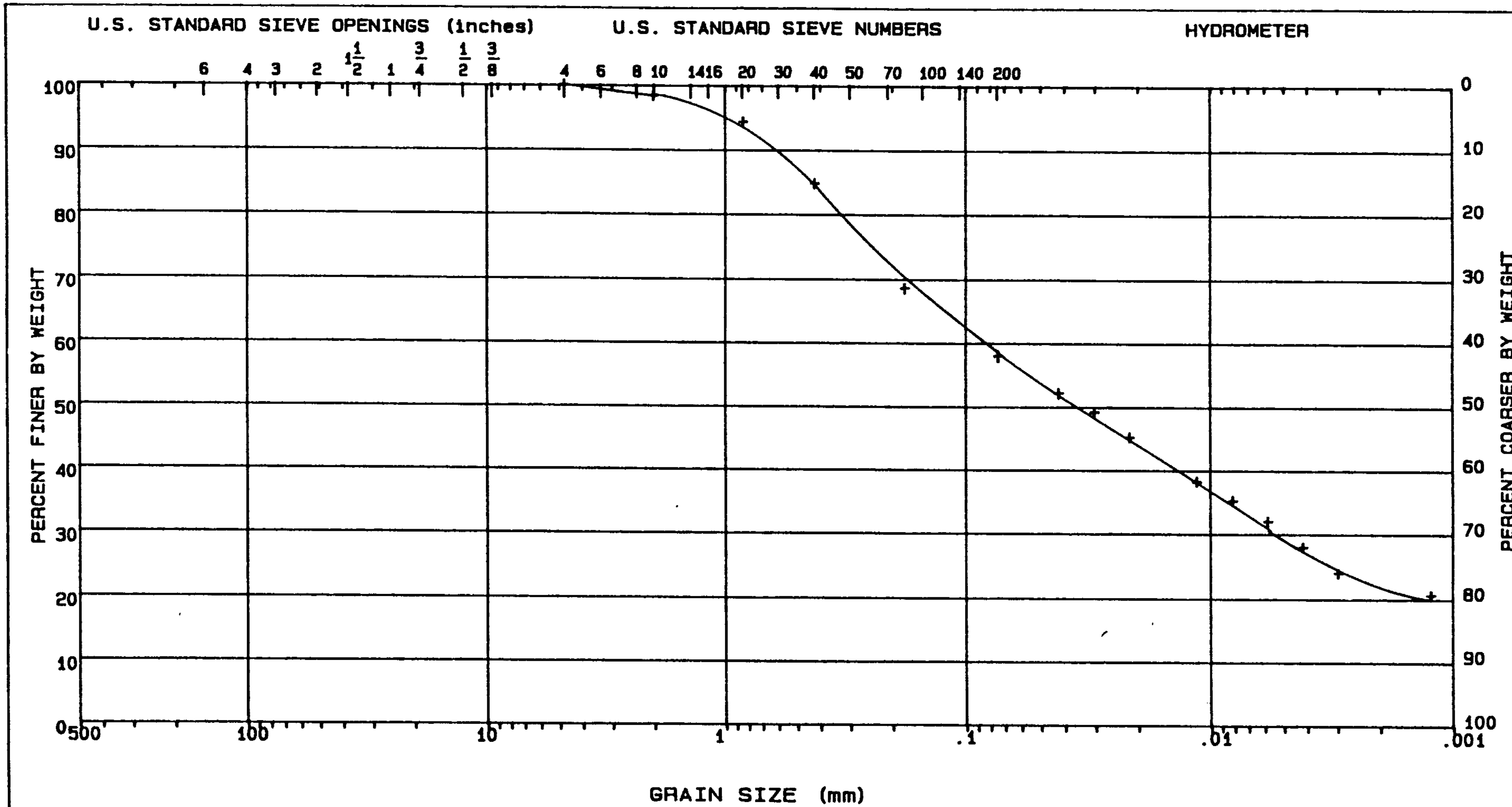
CLASSIFICATION Sandy clay, CH

LL 55 | PL 19 | PI 36 | G. 2.7 EST.

REMARKS Black. Torvane = 0.325 TSF
Slightly organic, non-calcareous.

PROJECT	CHASKA; CENCS-IA-90-78-ED-GH		
AREA	MRD LAB NO. : 90/358		
BORING NO.	90-132 MU	SAMPLE NO.	S-1
DEPTH EL	14'-16'	DATE	07-11-90

UNCONFINED COMPRESSION TEST REPORT



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

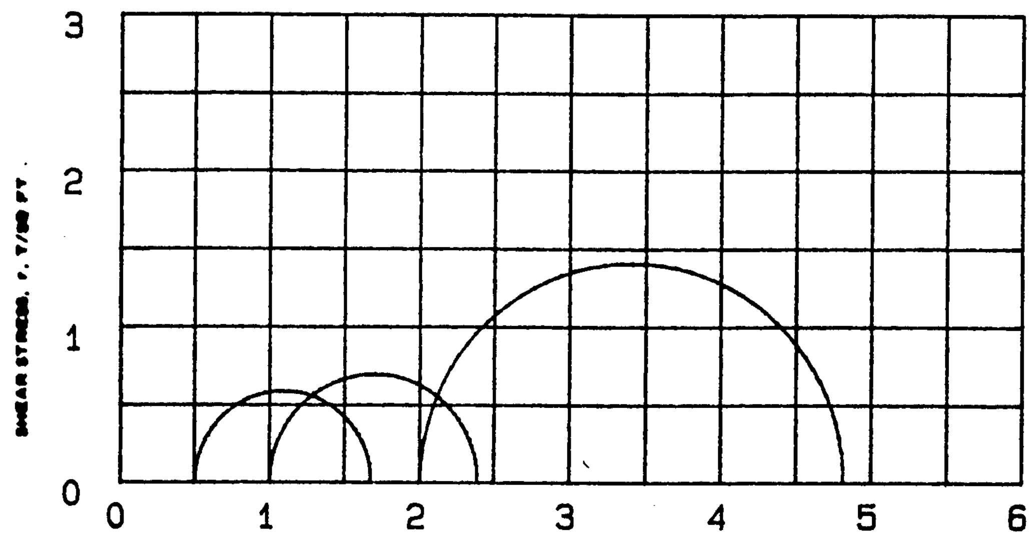
LL = 55	PL = 19	PI = 36	Gs = 2.88	NAT w = %

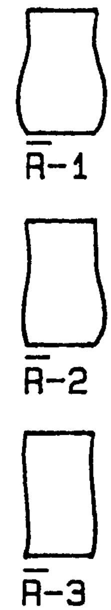
CLASSIFICATION Sandy clay, CH

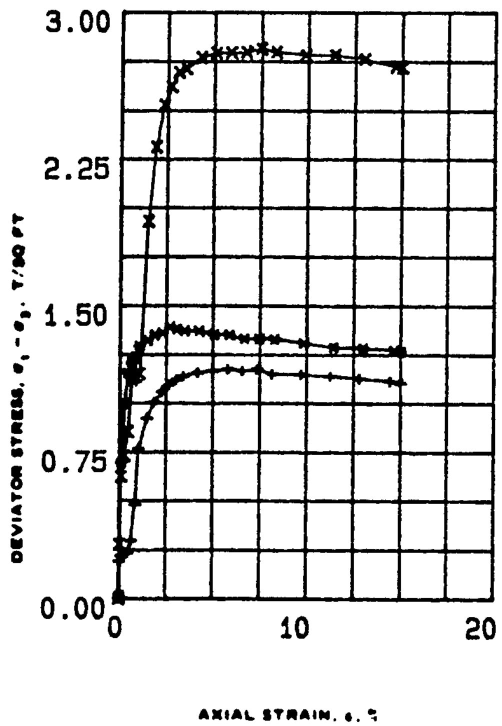
GRADATION CURVE

PROJECT	CHASKA; CENCS-IA-90-78-ED-GH
DATE	07-11-90
BORING NO.	90-132 MU
SAMPLE NO.	S-1
DEPTH/ELEV	14'-16'
MRD LAB NO.	90/358

FIGURE 8







			1 (+)	2 (✻)	3 (X)	
SPECIMEN NO.			1 (+)	2 (✻)	3 (X)	
INITIAL	WATER CONTENT, %	w_o	43.8	43.3	41.7	
INITIAL	DRY DENSITY LB/CU FT	γd_o	77.3	77.7	80.5	
INITIAL	SATURATION, %	S_o	97	97	99	
INITIAL	VOID RATIO	e_o	1.27	1.26	1.18	
BEFORE SHEAR	WATER CONTENT, %	w_c	41.7	39.8	33.9	
BEFORE SHEAR	DRY DENSITY LB/CU FT	γd_c	82	86.2	90	
BEFORE SHEAR	SATURATION, %	S_c	100	100	100	
BEFORE SHEAR	VOID RATIO	e_c	1.14	1.04	.95	
BEFORE SHEAR	FINAL BACK PRESSURE, T/SQ FT	u_o	4.103	4.103	4.103	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.5	1	2	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	1.174	1.390	2.813	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	600	300	840	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	1.101	1.265	2.719	
INITIAL DIAMETER, IN.		D_o	1.41	1.41	1.41	
INITIAL HEIGHT, IN.		H_o	2.99	2.98	2.99	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Fat clay, CH B-Value 1.0 1.0 1.0

LL 56	PL 22	PI 34	G_s 2.81	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST RBAR

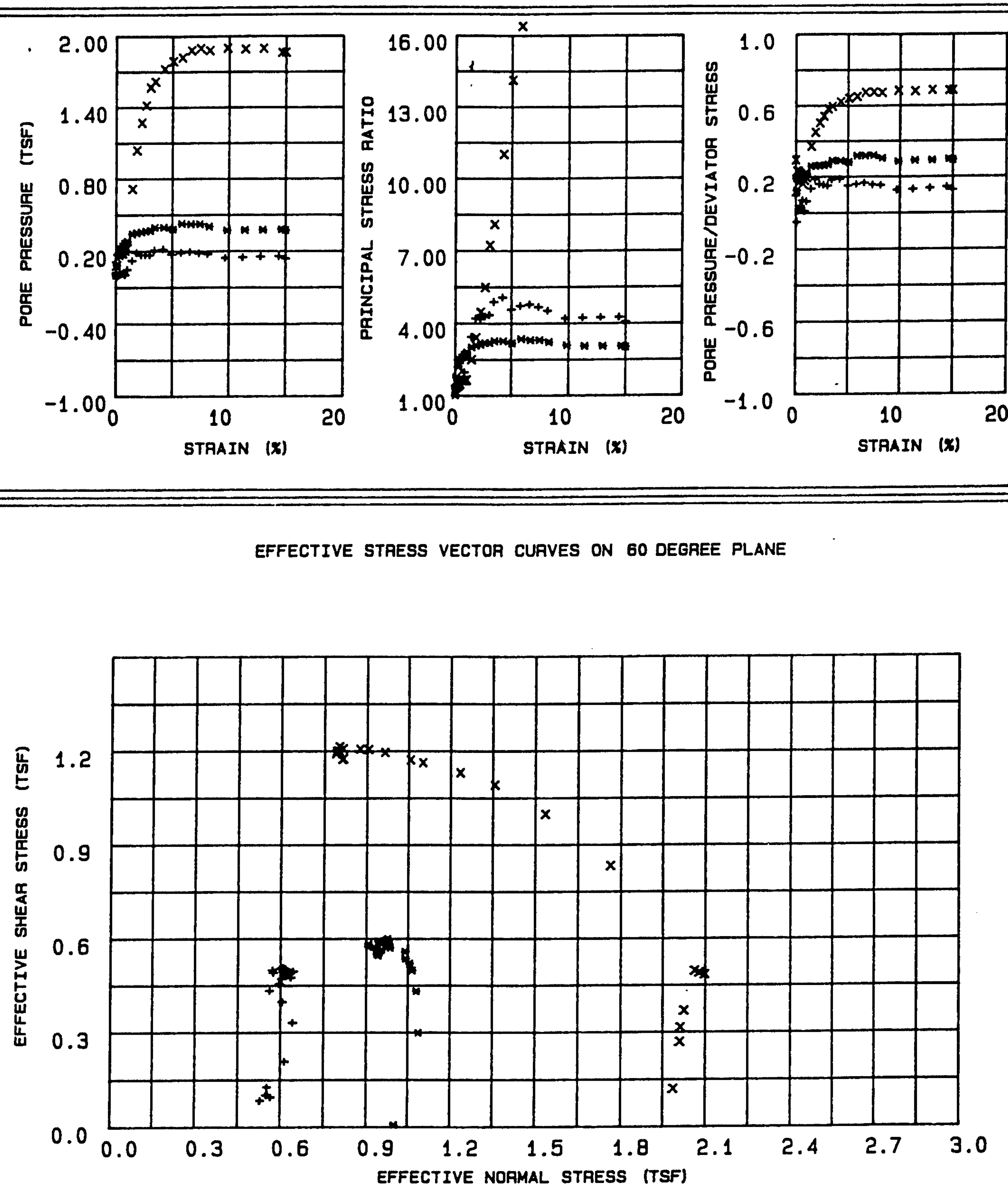
REMARKS: Gray-brown. Torvane=0.30 TSF
Slightly organic. Non-calcareous.

PROJECT	CHASKA; CENCS-IA-90-78-ED-GH
BORING NO 90-132 MU	SAMPLE NO. S-2
DEPTH ELEV	19'-21'
LABORATORY 90/358	DATE 07-31-90

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

FIGURE 9



LEGEND

+ = .5 TSF

✱ = 1 TSF

X = 2 TSF

PROJECT	CHASKA: CENCS-IA-90-78-ED-GH
BORING NO.	90-132 MU
SAMPLE NO.	S-2
DEPTH/ELEV	19'-21'
MRD LAB NO.	90/358

FIGURE 10

R

Table 4 - Triaxial $\bar{R}$ Test Results

Project : CHASKA; CENCS-IA-90-78-ED-GH
Boring Number : 90-132 MU
Sample Number : S-2
Depth : 19'-21'
Confining Pressure : .5 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.02	0.194	0.019	1.403	0.097	0.529	0.084
30	0.12	0.220	-0.012	1.430	-0.052	0.566	0.095
45	0.29	0.236	0.004	1.476	0.019	0.554	0.102
60	0.46	0.234	0.009	1.477	0.037	0.549	0.101
90	0.65	0.295	0.020	1.615	0.069	0.553	0.127
120	0.84	0.482	0.004	1.972	0.009	0.615	0.208
150	1.03	0.767	0.048	2.695	0.063	0.642	0.331
180	1.47	0.921	0.123	3.439	0.134	0.605	0.397
210	1.85	1.003	0.187	4.208	0.187	0.561	0.433
240	2.26	1.057	0.167	4.176	0.159	0.595	0.456
300	2.65	1.093	0.167	4.285	0.154	0.604	0.472
360	3.04	1.120	0.166	4.353	0.149	0.611	0.484
420	3.44	1.138	0.208	4.893	0.183	0.574	0.491
[illegible]80	4.21	1.157	0.216	5.077	0.188	0.570	0.499
[illegible]40	4.98	1.166	0.173	4.566	0.149	0.616	0.503
600	5.78	1.174	0.185	4.723	0.158	0.606	0.507
720	6.57	1.165	0.192	4.782	0.165	0.597	0.503
840	7.37	1.173	0.180	4.669	0.154	0.610	0.506
960	8.16	1.147	0.173	4.509	0.151	0.611	0.495
1080	9.70	1.146	0.141	4.195	0.124	0.643	0.495
1200	11.24	1.136	0.147	4.219	0.130	0.634	0.490
1320	12.81	1.125	0.153	4.239	0.136	0.625	0.485
1440	14.42	1.111	0.157	4.242	0.142	0.618	0.480
1481	15.00	1.101	0.137	4.052	0.125	0.635	0.475

Table 5 - Triaxial $\bar{R}$ Test Results

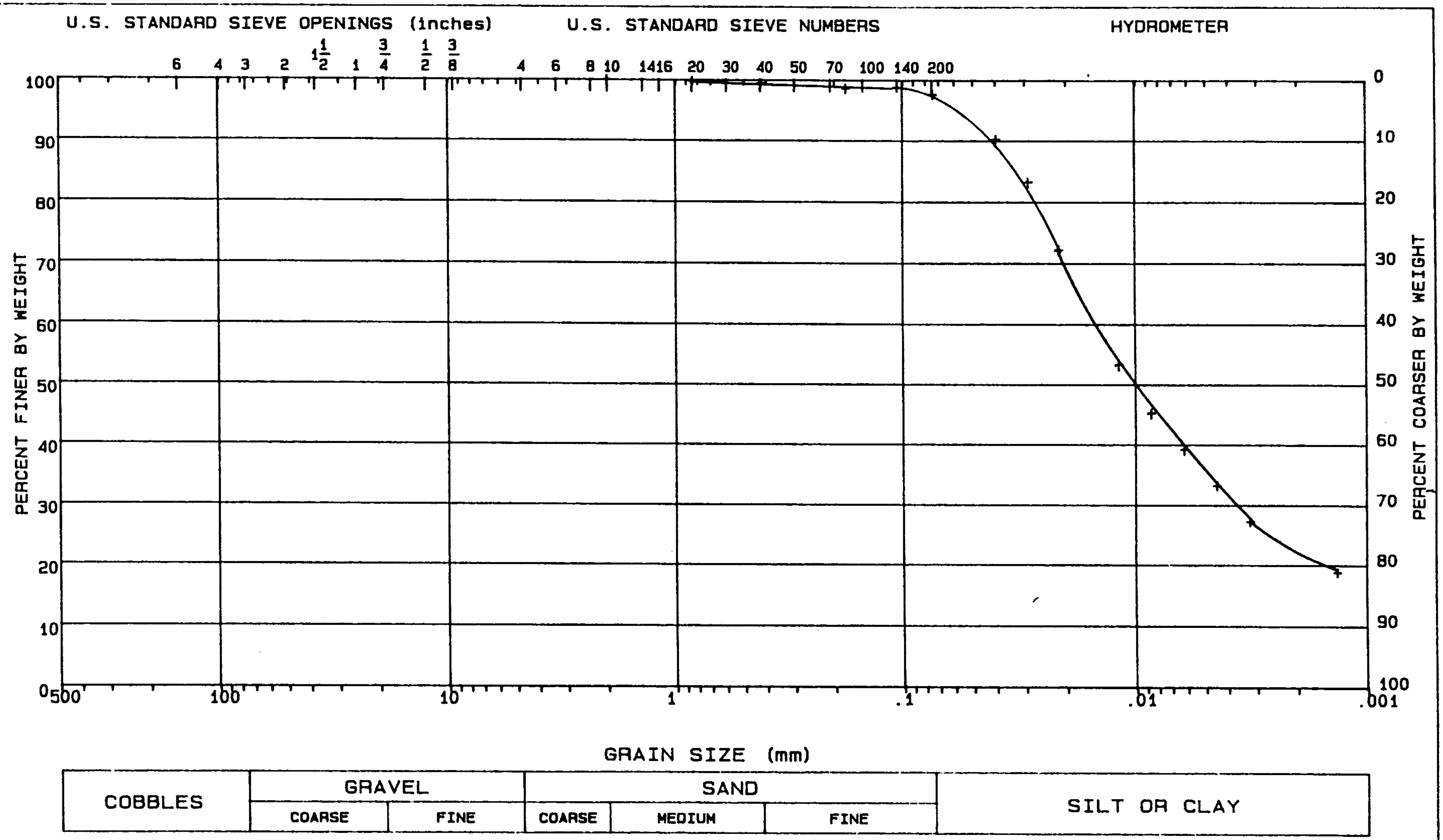
Project : CHASKA; CENCS-IA-90-78-ED-GH
Boring Number : 90-132 MU
Sample Number : S-2
Depth : 19'-21'
Confining Pressure : 1 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.02	0.015	0.003	1.015	0.192	1.001	0.006
30	0.12	0.694	0.085	1.759	0.124	1.087	0.299
45	0.29	1.001	0.168	2.204	0.168	1.080	0.432
60	0.46	1.153	0.221	2.481	0.192	1.064	0.498
90	0.66	1.207	0.244	2.596	0.202	1.055	0.521
120	0.86	1.241	0.266	2.691	0.215	1.041	0.536
150	1.05	1.294	0.280	2.798	0.217	1.040	0.559
180	1.49	1.323	0.342	3.010	0.259	0.986	0.571
210	1.88	1.352	0.352	3.085	0.260	0.983	0.584
240	2.30	1.361	0.359	3.122	0.264	0.978	0.588
300	2.69	1.390	0.367	3.195	0.264	0.977	0.600
360	3.08	1.380	0.371	3.195	0.269	0.971	0.596
420	3.50	1.371	0.396	3.270	0.290	0.943	0.592
480	4.28	1.370	0.395	3.265	0.289	0.944	0.591
540	5.06	1.352	0.380	3.178	0.281	0.955	0.583
600	5.87	1.350	0.427	3.357	0.317	0.907	0.583
720	6.67	1.331	0.422	3.301	0.317	0.908	0.574
840	7.48	1.330	0.422	3.298	0.318	0.907	0.574
960	8.29	1.328	0.401	3.215	0.302	0.928	0.573
080	9.85	1.307	0.370	3.074	0.283	0.954	0.564
200	11.42	1.286	0.373	3.050	0.290	0.945	0.555
320	13.01	1.281	0.374	3.046	0.292	0.943	0.553
440	14.65	1.273	0.378	3.048	0.297	0.937	0.550
464	15.00	1.265	0.371	3.011	0.293	0.942	0.546

Table 6 - Triaxial $\bar{R}$ Test Results

Project : CHASKA; CENCS-IA-90-78-ED-GH
Boring Number : 90-132 MU
Sample Number : S-2
Depth : 19'-21'
Confining Pressure : 2 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.02	0.278	0.082	1.145	0.294	1.987	0.120
30	0.12	0.623	0.144	1.335	0.232	2.010	0.269
45	0.29	0.729	0.168	1.398	0.231	2.012	0.315
60	0.46	0.853	0.186	1.470	0.218	2.025	0.368
90	0.66	1.121	0.180	1.616	0.161	2.098	0.484
120	0.86	1.135	0.203	1.632	0.179	2.078	0.490
150	1.05	1.149	0.222	1.646	0.194	2.062	0.496
180	1.49	1.930	0.715	2.502	0.371	1.763	0.833
210	1.88	2.312	1.038	3.402	0.449	1.534	0.998
240	2.30	2.529	1.270	4.465	0.503	1.356	1.092
300	2.69	2.621	1.416	5.488	0.541	1.233	1.131
360	3.08	2.695	1.567	7.223	0.582	1.100	1.163
420	3.49	2.714	1.617	8.091	0.596	1.055	1.172
480	4.28	2.771	1.723	11.007	0.622	0.963	1.196
540	5.06	2.792	1.787	14.126	0.641	0.904	1.205
600	5.87	2.794	1.819	16.395	0.651	0.873	1.206
720	6.67	2.796	1.879	24.151	0.673	0.813	1.207
840	7.48	2.813	1.897	28.207	0.675	0.800	1.214
960	8.29	2.797	1.879	24.160	0.672	0.813	1.207
1080	9.85	2.781	1.898	28.356	0.683	0.791	1.200
1200	11.41	2.781	1.890	26.198	0.680	0.798	1.200
1320	13.01	2.761	1.895	27.257	0.687	0.788	1.191
1440	14.64	2.722	1.860	20.462	0.684	0.814	1.175
1465	15.00	2.719	1.863	20.829	0.686	0.811	1.174



LL = 56	PL = 22	PI = 34	Gs = 2.58	NAT w = %

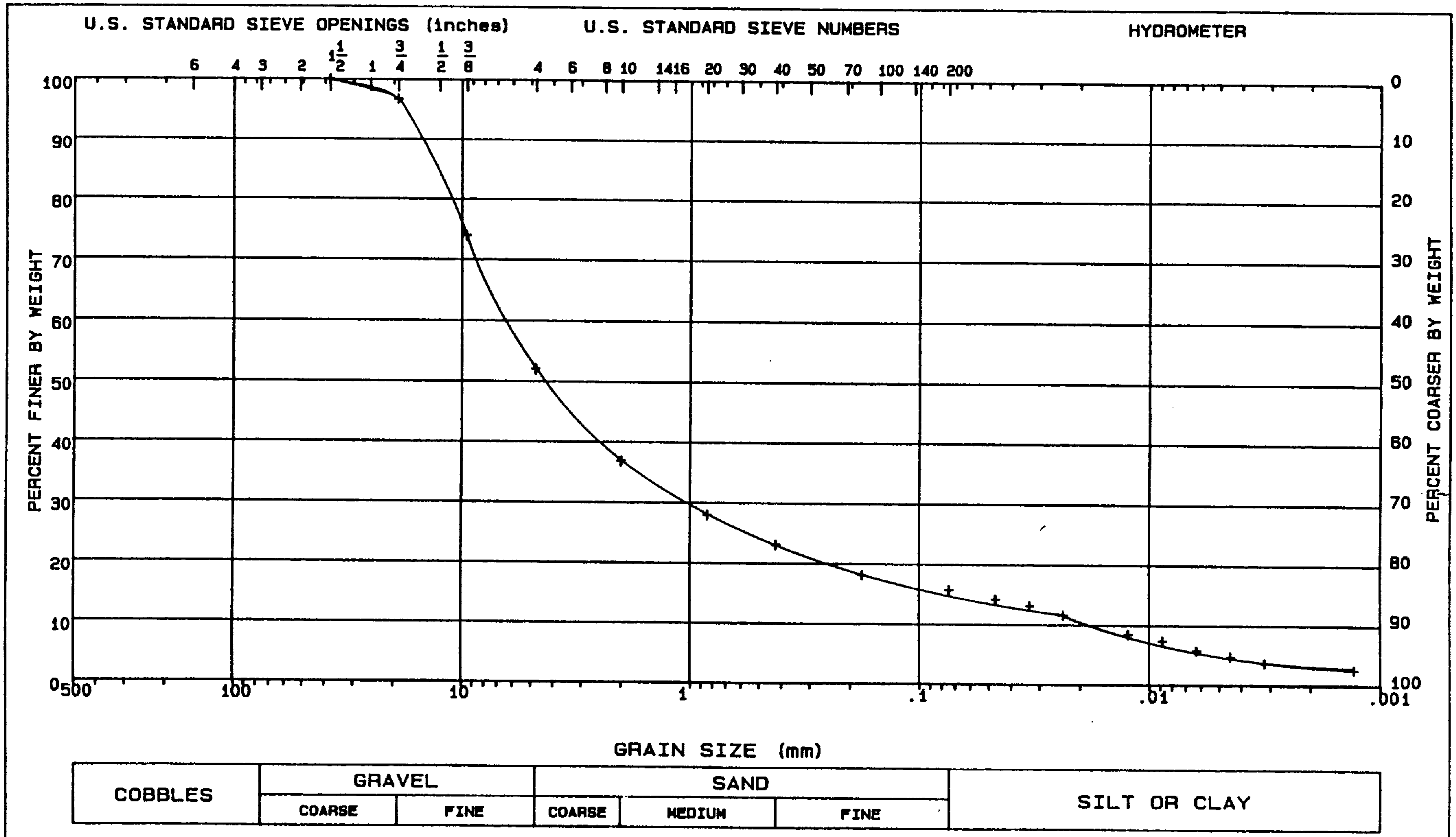
CLASSIFICATION Trimming from Triaxial R-Bar Tests.
Fat clay, CH

GRADATION CURVE

PROJECT	CHASKA; CENCS-IA-90-78-ED-GH
DATE	08-01-90
BORING NO.	90-132 MU
SAMPLE NO.	S-2 (TOP)
DEPTH/ELEV	19'-21'
MRD LAB NO.	90/358

FIGURE 11

FIGURE D-58



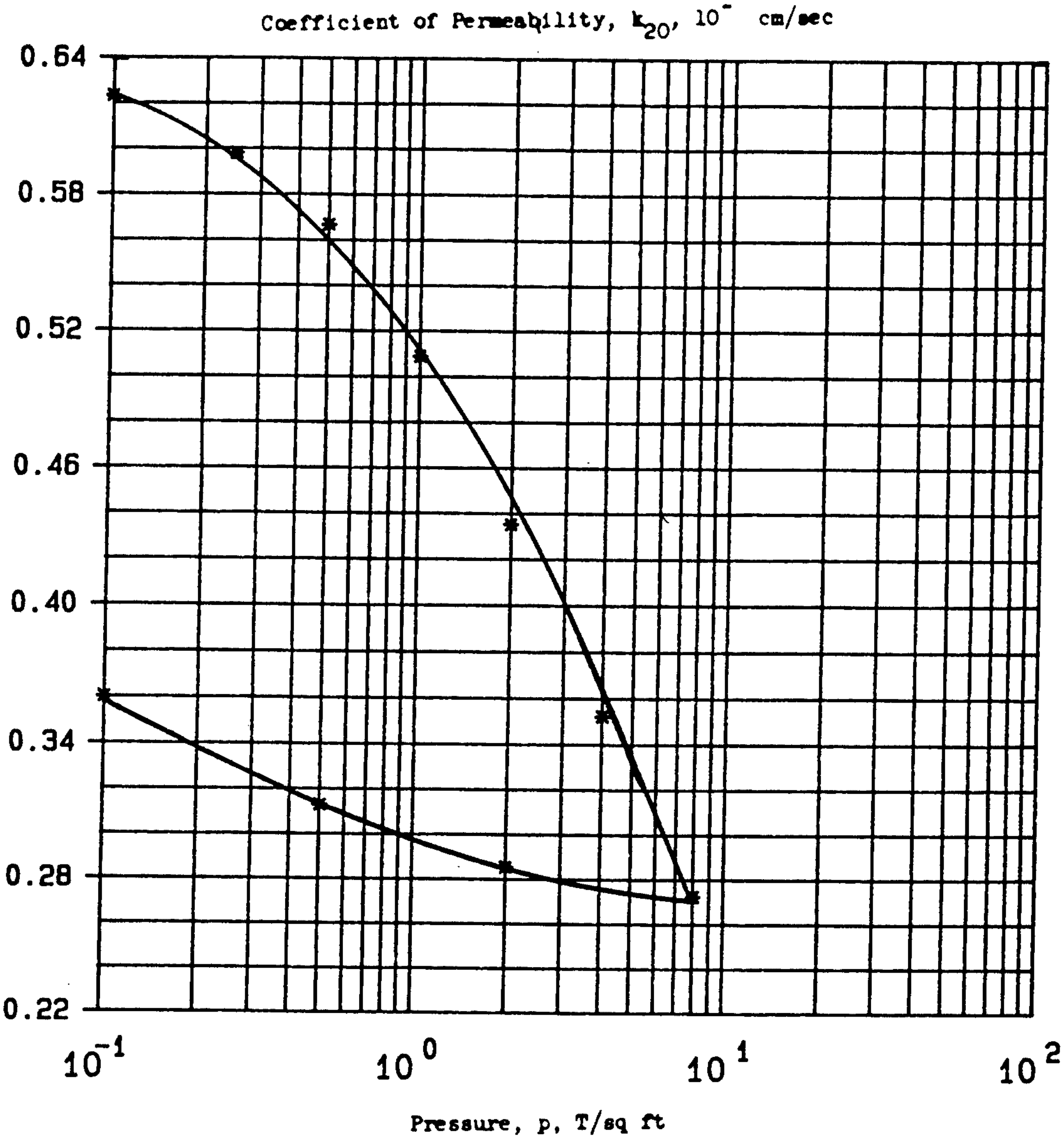
LL = 35	PL = 18	PI = 17	Gs = 2.81	NAT w = %

CLASSIFICATION Clayey sandy gravel, GC

GRADATION CURVE

PROJECT	CHASKA; CENCS-IA-90-78-ED-GH
DATE	08-03-90
BORING NO.	90-132 MU
SAMPLE NO.	S-2 (BOT.)
DEPTH/ELEV	19'-21'
MRD LAB NO.	90/358

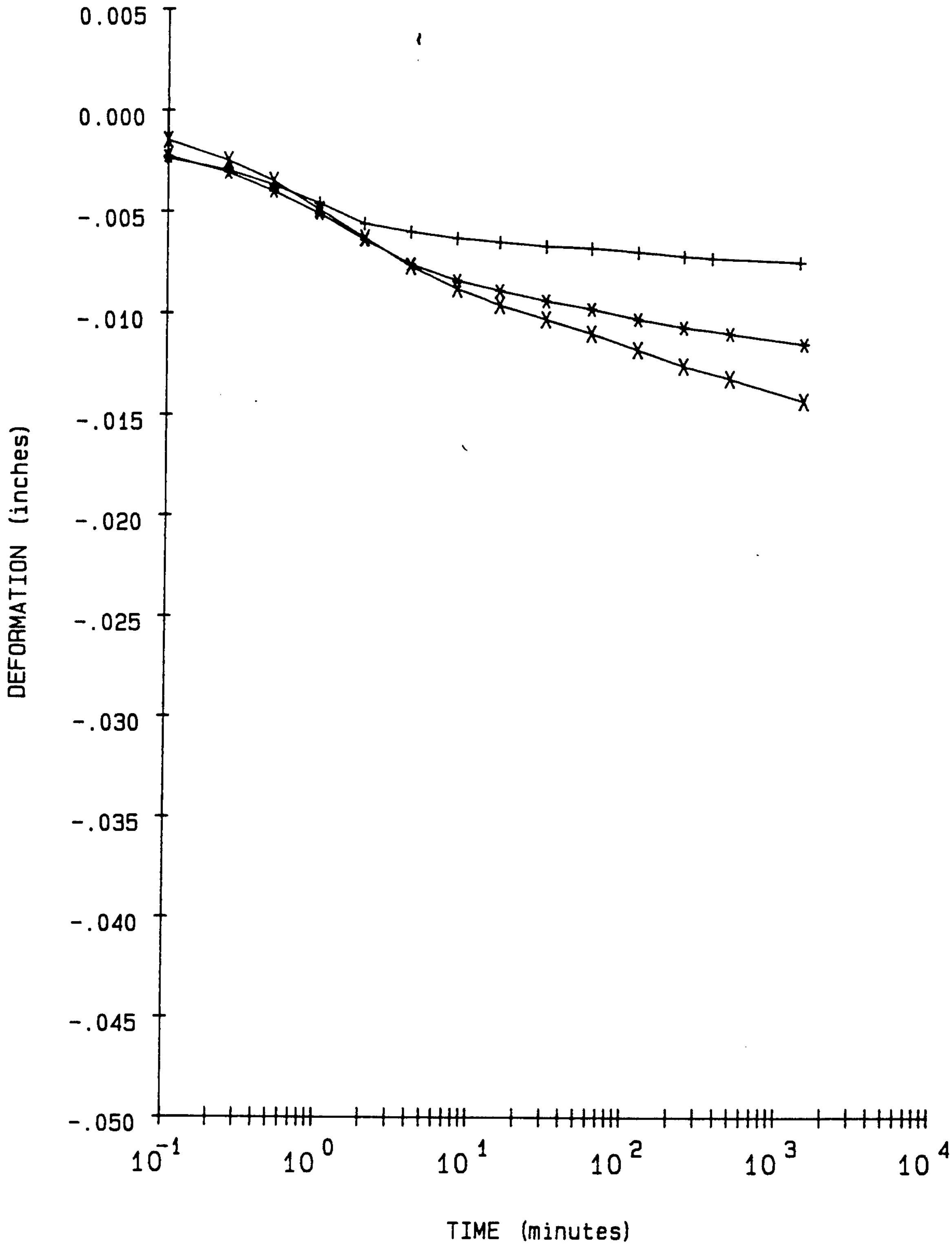
FIGURE 12



Type of Specimen UNDISTURBED		Before Test		After Test	
Diam 2.5 in.	Ht .75 in.	Water Content, w_o	21.1 %	w_f	21.1 %
Overburden Pressure, Po T/sq ft		Void Ratio, e_o	0.64	e_f	0.36
Preconsol. Pressure, Pc T/sq ft		Saturation, S_o	77 %	S_f	100 %
Compression Index, C_c		Dry Density, γ_d	88.3 lb/ft^3		
Classification Sandy clay, CH		k_{20} at e_o = x 10^{-} cm/sec			
LL 115	G_s 2.32	Project CHASKA; CENCS-IA-90-78-ED-GH			
PL 46	D_{10}				
Remarks Black. Too soft for		Area MRD LAB NO. 90/358			
Torvane, organic. Non-calcareous		Boring No. 90-133 MU		Sample No. S-1	
		Depth El 8'-10'		Date 07-17-90	
		CONSOLIDATION TEST REPORT			

ENG FORM 1 MAY 63 2090 PREVIOUS EDITIONS ARE OBSOLETE.

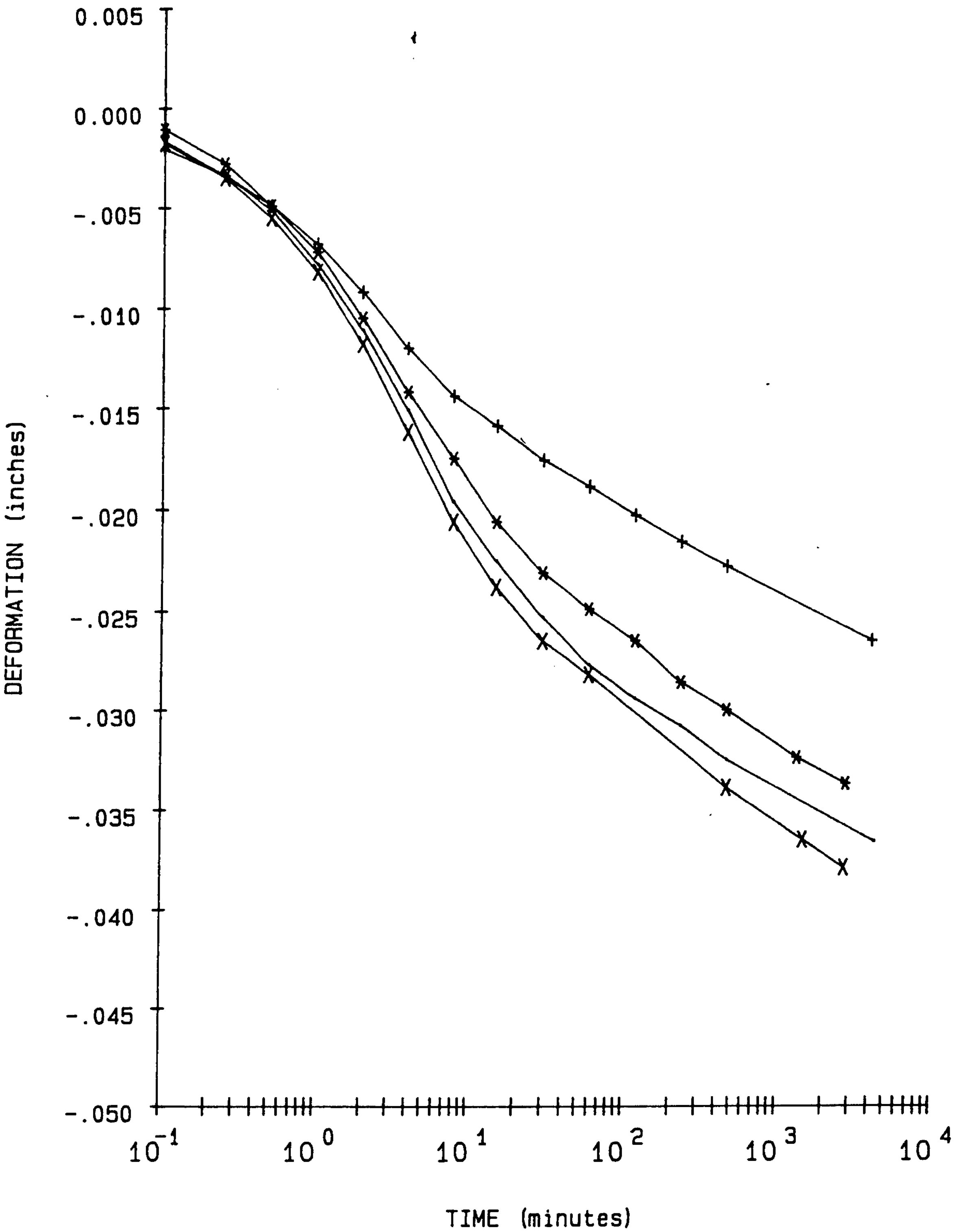
Figure 13



LEGEND	
+ = .1 TSF Wet	
* = .25 TSF	
X = .5 TSF	

PROJECT	CHASKA: CENCS-IA-90-78-ED-GH
BORING NO.	90-133 MU
SAMPLE NO.	S-1
DEPTH/ELEV	8'-10'
MRD LAB NO.	90/358

FIGURE 14

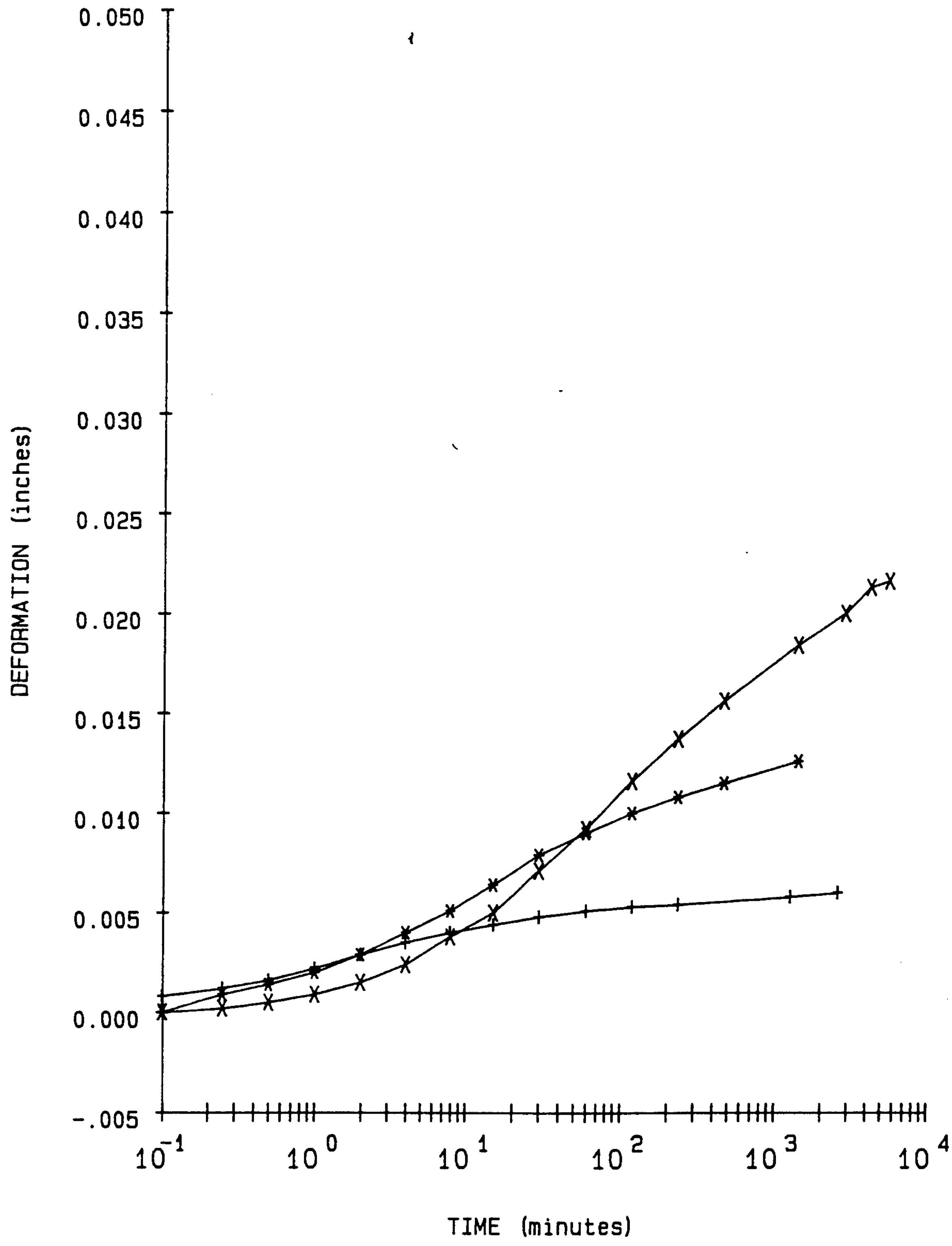


LEGEND	
+ = 1	TSF
✱ = 2	TSF
X = 4	TSF
– = 8	TSF

PROJECT	CHASKA; CENCS-IA-90-78-ED-GH
BORING NO.	90-133 MU
SAMPLE NO.	S-1
DEPTH/ELEV	8'-10'
MRD LAB NO.	90/358

FIGURE 15

C1



LEGEND
+ = 2 TSF Rebound
* = .5 TSF Rebound
X = .1 TSF Rebound

PROJECT	CHASKA; CENCS-IA-90-78-ED-GH
BORING NO.	90-133 MU
SAMPLE NO.	S-1
DEPTH/ELEV	8'-10'
MRD LAB NO.	90/358

FIGURE 16

Consolidation Test Data

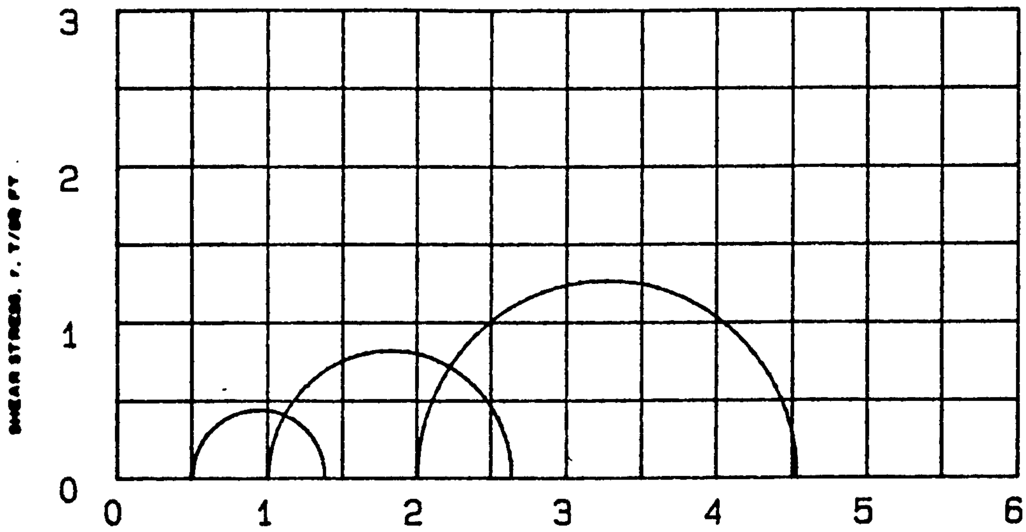
Project CHASKA; CENCS-IA-90-78-ED-GH

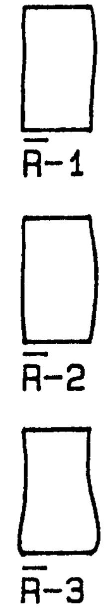
Boring No. 90-133 MU
Sample No. S-1
Depth/Elev 8'-10'
MRD Lab No. 90/358

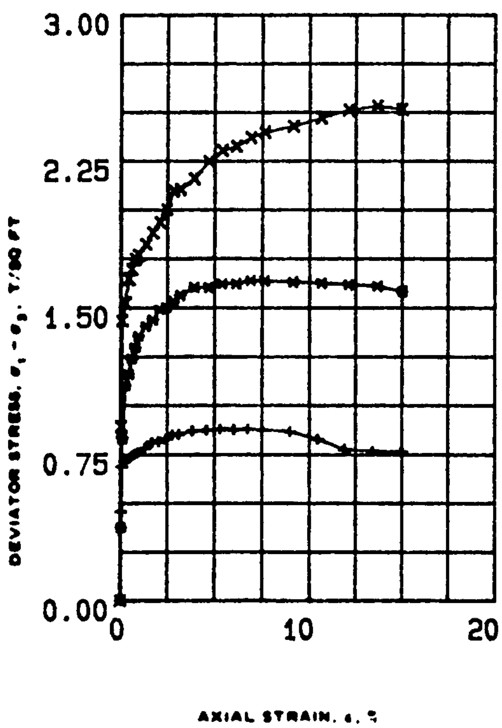
Gs = 2.32
eo = 0.639
0.42eo = 0.268

Water Content (%)	Dry Weight (gms)	Dry Density (PCF)	Void Ratio	Pressure (TSF)	Saturation (%)
21.1	85.4	88.3	0.639		76.6
21.1	85.4	89.2	0.623	0.10	78.6
21.1	85.4	90.6	0.598	0.25	81.9
21.1	85.4	92.4	0.567	0.50	86.4
21.1	85.4	96.0	0.509	1.00	96.3
21.1	85.4	100.9	0.435	2.00	100.0
21.1	85.4	107.1	0.352	4.00	100.0
21.1	85.4	113.8	0.272	8.00	100.0
21.1	85.4	112.6	0.285	2.00	100.0
21.1	85.4	110.3	0.313	0.50	100.0
21.1	85.4	106.5	0.360	0.10	100.0

Axial Strain (%)	Void Ratio
1	0.623
2	0.606
3	0.590
4	0.574
5	0.557
6	0.541
7	0.525
8	0.508
9	0.492
10	0.475
11	0.459
12	0.443
13	0.426
14	0.410
15	0.393
16	0.377
17	0.361
18	0.344
19	0.328
20	0.311







SPECIMEN NO.			1 (+)	2 (*)	3 (X)	
INITIAL	WATER CONTENT, %	w_o	89.9	76.6	71.7	
	DRY DENSITY LB/CU FT	γd_o	47.3	54.4	56.5	
	SATURATION, %	S_o	100	100	100	
	VOID RATIO	e_o	2.06	1.66	1.57	
BEFORE SHEAR	WATER CONTENT, %	w_c	83.3	57.1	59.5	
	DRY DENSITY LB/CU FT	γd_c	51.4	62.4	64.8	
	SATURATION, %	S_c	100	100	100	
	VOID RATIO	e_c	1.82	1.32	1.24	
	FINAL BACK PRESSURE, T/SQ FT	u_o	5.543	5.543	5.543	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.5	1	2	
MAXIMUM DEVIATOR STRESS, T/SQ FT	$(\sigma_1 - \sigma_3)_{MAX}$		0.878	1.638	2.530	
TIME TO $(\sigma_1 - \sigma_3)_{MAX}$, MIN		t_f	600	840	1440	
ULTIMATE DEVIATOR STRESS, T/SQ FT	$(\sigma_1 - \sigma_3)_{ULT}$		0.759	1.582	2.514	
INITIAL DIAMETER, IN.		D_o	1.38	1.38	1.38	
INITIAL HEIGHT, IN.		H_o	3	3	3	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Sandy clay, CH B-Value 1.0 1.0 1.0

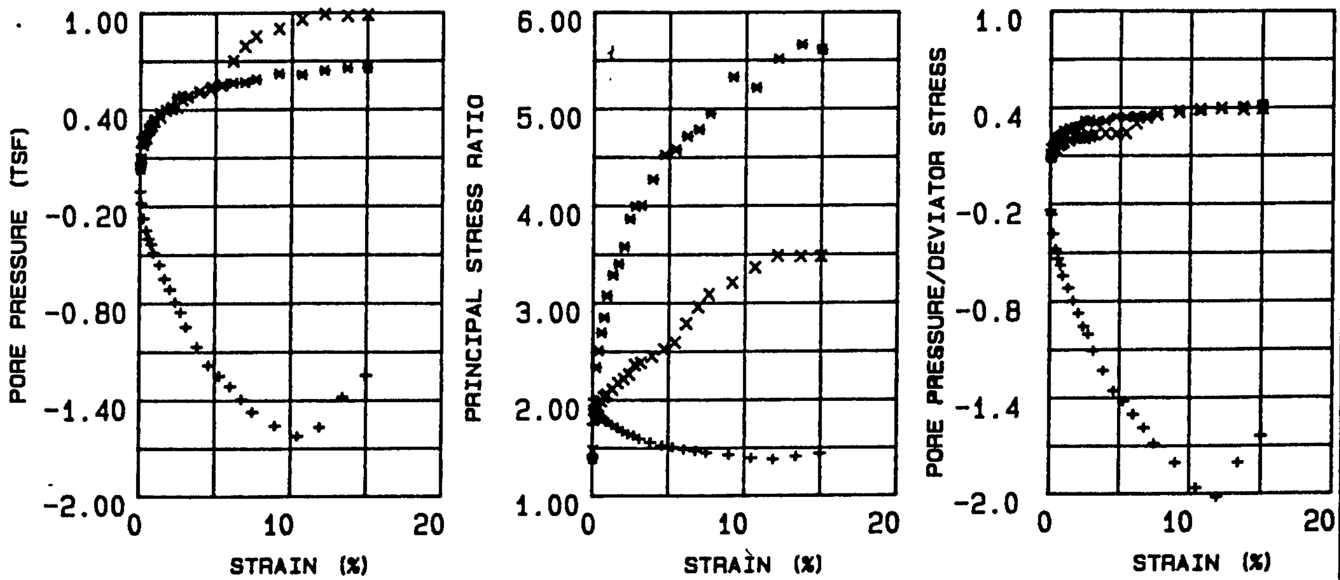
LL 115	PL 46	PI 69	GS 2.32	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST RBAR

REMARKS:	
Black. Too soft for Torvane, oranic. Non calcareous. The high water contents and the low dry density were probably due to burning the organic material in high temp. oven (210°F) during the drying procedure.	PROJECT CHASKA; CENCS-IA-90-78-ED-6H
	BORING NO 90-133 MU — SAMPLE NO. S-1
	DEPTH ELEV 8'-10'
	LABORATORY 90/358 — DATE 07-12-90
	TRIAXIAL COMPRESSION TEST REPORT

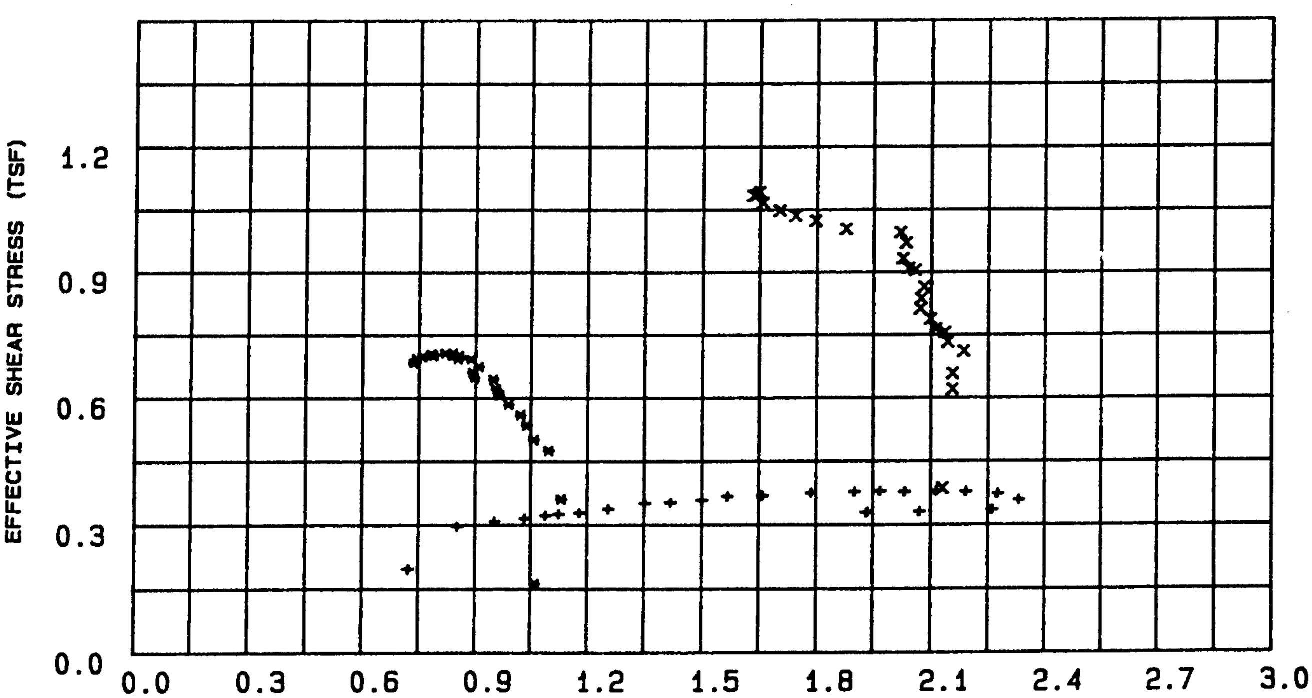
ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

FIGURE 17

The results of pore pressure for specimen #1 are questionable due to a malfunction of the Transducer.



EFFECTIVE STRESS VECTOR CURVES ON 60 DEGREE PLANE



LEGEND	
+ =	.5 TSF
✱ =	1 TSF
X =	2 TSF

PROJECT	CHASKA: CENCS-IA-90-78-ED-GH
BORING NO.	90-133 MU
SAMPLE NO.	S-1
DEPTH/ELEV	8'-10'
MRD LAB NO.	90/358

FIGURE 18

FIGURE D-66

R

Table 7 - Triaxial $\bar{R}$ Test Results

Project : CHASKA; CENCS-IA-90-78-ED-GH
Boring Number : 90-133 MU
Sample Number : S-1
Depth : 8'-10'
Confining Pressure : .5 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.05	0.456	-0.110	1.748	-0.240	0.723	0.197
30	0.10	0.687	-0.182	2.006	-0.265	0.852	0.296
45	0.26	0.713	-0.276	1.918	-0.387	0.952	0.308
60	0.44	0.729	-0.352	1.856	-0.482	1.033	0.315
90	0.60	0.745	-0.403	1.826	-0.540	1.088	0.322
120	0.77	0.752	-0.438	1.802	-0.581	1.124	0.325
150	0.94	0.759	-0.491	1.766	-0.646	1.179	0.328
180	1.33	0.781	-0.563	1.734	-0.721	1.256	0.337
210	1.69	0.813	-0.651	1.706	-0.800	1.352	0.351
240	2.05	0.816	-0.717	1.671	-0.878	1.419	0.352
300	2.41	0.829	-0.796	1.639	-0.960	1.501	0.358
360	2.77	0.850	-0.857	1.626	-1.008	1.568	0.367
420	3.13	0.853	-0.949	1.589	-1.112	1.660	0.368
480	3.85	0.868	-1.072	1.552	-1.234	1.787	0.375
540	4.60	0.873	-1.187	1.517	-1.359	1.903	0.377
600	5.30	0.878	-1.252	1.501	-1.425	1.969	0.379
720	6.02	0.874	-1.317	1.481	-1.506	2.033	0.377
840	6.77	0.878	-1.398	1.463	-1.591	2.115	0.379
960	7.49	0.873	-1.476	1.442	-1.690	2.192	0.377
1080	8.99	0.863	-1.562	1.419	-1.809	2.276	0.372
1200	10.46	0.827	-1.627	1.389	-1.967	2.332	0.357
1320	11.90	0.774	-1.568	1.374	-2.025	2.260	0.334
1440	13.40	0.764	-1.380	1.406	-1.807	2.069	0.330
1560	14.96	0.760	-1.246	1.435	-1.640	1.934	0.328
1563	15.00	0.759	-1.245	1.435	-1.639	1.933	0.328

Table 8 - Triaxial $\bar{R}$ Test Results

Project : CHASKA; CENCS-IA-90-78-ED-GH
Boring Number : 90-133 MU
Sample Number : S-1
Depth : 8'-10'
Confining Pressure : 1 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.05	0.375	0.032	1.387	0.086	1.061	0.162
30	0.10	0.834	0.075	1.901	0.090	1.131	0.360
45	0.27	1.101	0.176	2.337	0.160	1.097	0.475
60	0.44	1.160	0.230	2.507	0.199	1.057	0.501
90	0.61	1.239	0.269	2.695	0.218	1.038	0.535
120	0.79	1.297	0.300	2.852	0.232	1.021	0.560
150	0.96	1.355	0.347	3.076	0.257	0.989	0.585
180	1.35	1.407	0.384	3.286	0.274	0.964	0.607
210	1.72	1.439	0.401	3.404	0.279	0.955	0.621
240	2.09	1.491	0.422	3.578	0.283	0.947	0.644
300	2.45	1.502	0.476	3.865	0.317	0.896	0.648
360	2.82	1.533	0.488	3.992	0.319	0.891	0.662
420	3.19	1.564	0.479	4.002	0.307	0.908	0.675
480	3.93	1.604	0.510	4.271	0.318	0.887	0.692
540	4.69	1.603	0.545	4.524	0.341	0.852	0.692
600	5.40	1.622	0.547	4.580	0.338	0.855	0.700
720	6.14	1.621	0.564	4.717	0.348	0.837	0.700
840	6.90	1.638	0.567	4.786	0.347	0.839	0.707
960	7.64	1.636	0.586	4.951	0.359	0.819	0.706
080	9.16	1.630	0.623	5.326	0.383	0.781	0.704
200	10.66	1.624	0.615	5.214	0.379	0.787	0.701
320	12.13	1.617	0.642	5.514	0.397	0.758	0.698
440	13.65	1.608	0.655	5.664	0.408	0.743	0.694
541	15.00	1.582	0.657	5.608	0.416	0.735	0.683
541	15.00	1.582	0.657	5.608	0.416	0.735	0.683

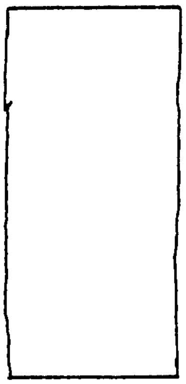
FIGURE D-68

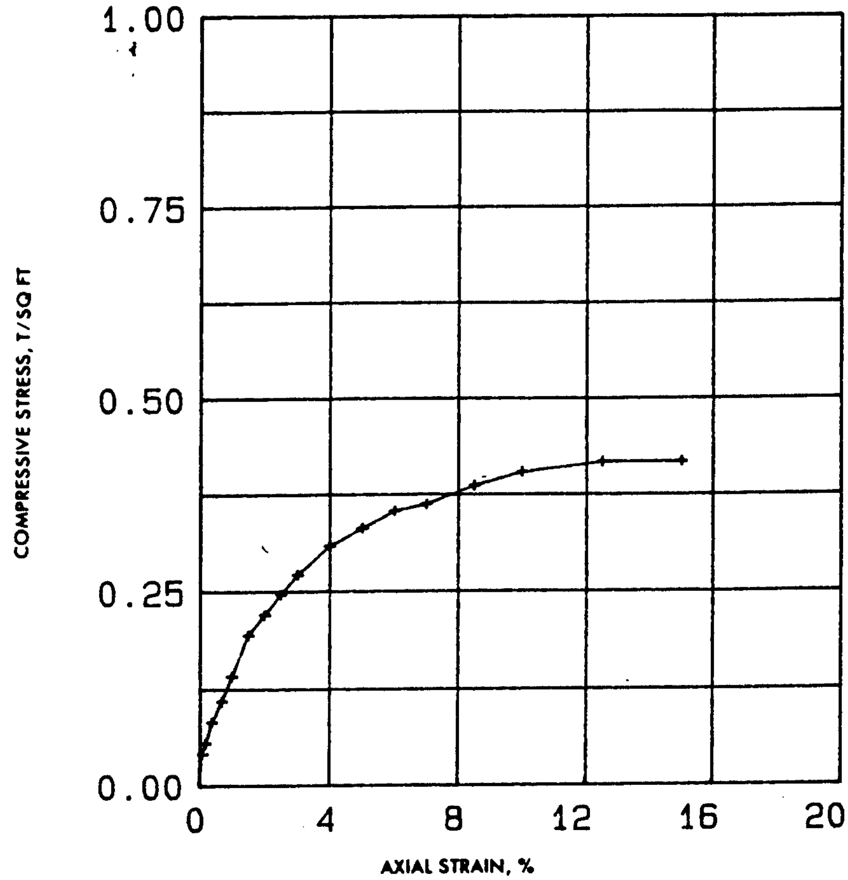
Table 9 - Triaxial $\bar{R}$ Test Results

Project : CHASKA; CENCS-IA-90-78-ED-GH
Boring Number : 90-133 MU
Sample Number : S-1
Depth : 8'-10'
Confining Pressure : 2 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.05	0.892	0.091	1.467	0.103	2.130	0.385
30	0.10	1.434	0.200	1.796	0.140	2.155	0.619
45	0.27	1.523	0.222	1.857	0.146	2.155	0.657
60	0.44	1.645	0.223	1.926	0.136	2.184	0.710
90	0.61	1.696	0.278	1.985	0.164	2.142	0.732
120	0.79	1.748	0.299	2.028	0.172	2.134	0.755
150	0.96	1.768	0.327	2.056	0.185	2.111	0.763
180	1.35	1.823	0.354	2.107	0.195	2.097	0.787
210	1.72	1.882	0.396	2.173	0.211	2.070	0.812
240	2.09	1.936	0.407	2.216	0.211	2.072	0.836
300	2.45	2.001	0.416	2.264	0.208	2.080	0.864
360	2.82	2.095	0.462	2.362	0.221	2.057	0.904
420	3.19	2.105	0.481	2.385	0.229	2.040	0.908
480	3.93	2.159	0.510	2.449	0.237	2.025	0.932
[illegible]40	4.69	2.247	0.523	2.522	0.233	2.033	0.970
600	5.40	2.304	0.553	2.592	0.240	2.018	0.995
720	6.14	2.324	0.699	2.786	0.301	1.876	1.003
840	6.90	2.369	0.791	2.960	0.335	1.796	1.023
960	7.63	2.397	0.852	3.089	0.356	1.742	1.035
1080	9.16	2.428	0.900	3.208	0.371	1.701	1.048
1200	10.65	2.471	0.955	3.364	0.387	1.657	1.066
1320	12.13	2.511	0.990	3.485	0.395	1.632	1.084
1440	13.65	2.530	0.978	3.476	0.387	1.648	1.092
1541	15.00	2.514	0.985	3.478	0.392	1.637	1.085
1541	15.00	2.514	0.985	3.478	0.392	1.637	1.085

FAILURE SKETCHES





☐ CONTROLLED STRESS

☒ CONTROLLED STRAIN

TEST NO.						
TYPE OF SPECIMEN UNDISTURBED						
INITIAL	WATER CONTENT	w_o	40.7 %	%	%	%
	VOID RATIO	e_o	0.82			
	SATURATION	S_o	100 %	%	%	%
	DRY DENSITY, LB/CU FT	γ_d	79.4			
TIME TO FAILURE, MIN		t_f	25.0			
UNCONFINED COMPRESSIVE STRENGTH, T/SQ FT		q_u	0.42			
UNDRAINED SHEAR STRENGTH, T/SQ FT		s_u	0.21			
SENSITIVITY RATIO		S_t				
INITIAL SPECIMEN DIAMETER, IN		D_o	1.41			
INITIAL SPECIMEN HEIGHT, IN.		H_o	2.96			

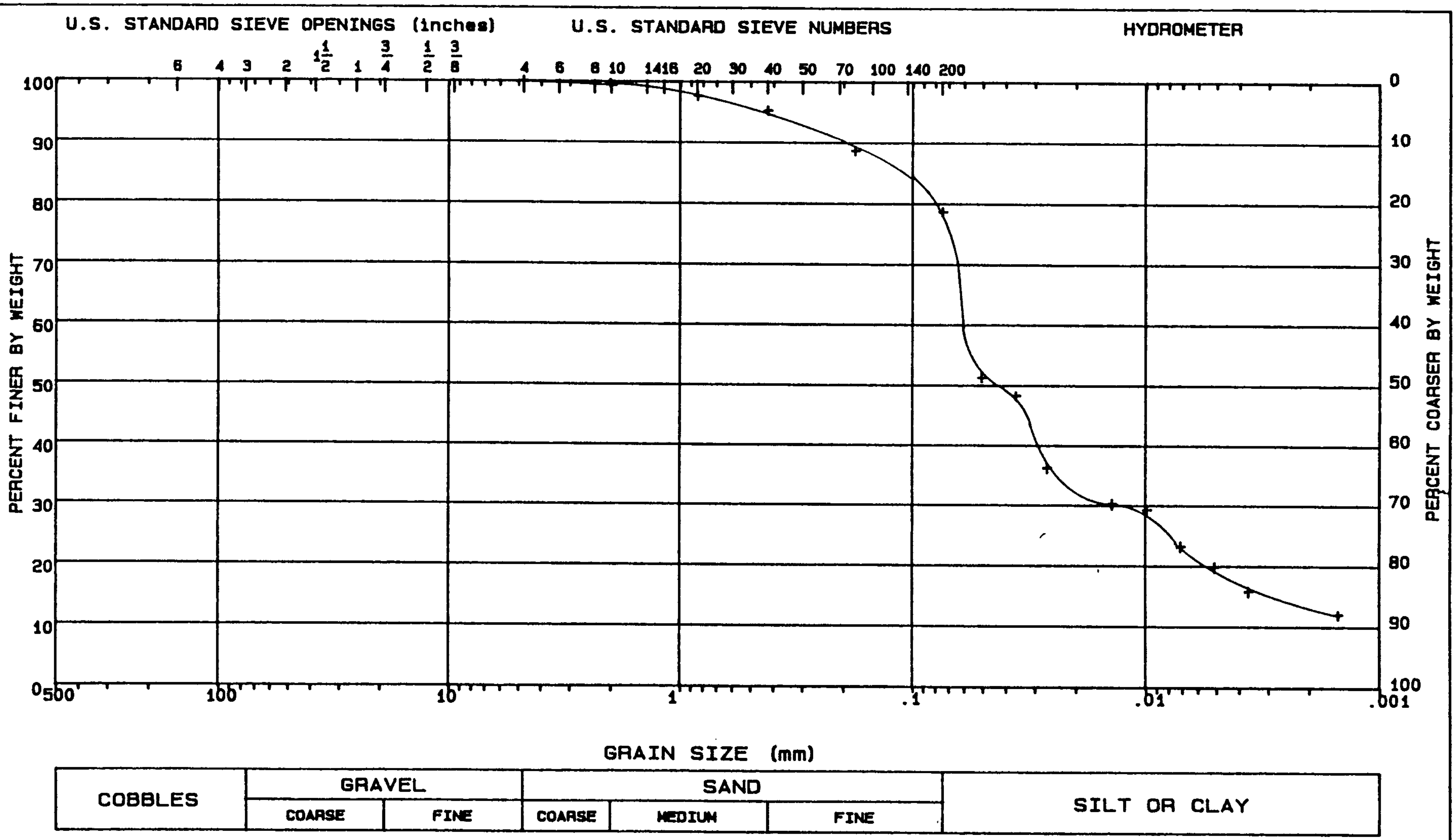
CLASSIFICATION Sandy clay, CH

LL 115	PL 46	PI 69	G_s 2.32

REMARKS Black. Too soft for Torvane, organic, non-calcareous.

PROJECT	CHASKA; CENCS-IA-90-78-ED-GH		
AREA	MRD LAB NO. : 90/358		
BORING NO.	90-133 MU	SAMPLE NO.	S-1
DEPTH EL	8'-10'	DATE	07-24-90

UNCONFINED COMPRESSION TEST REPORT



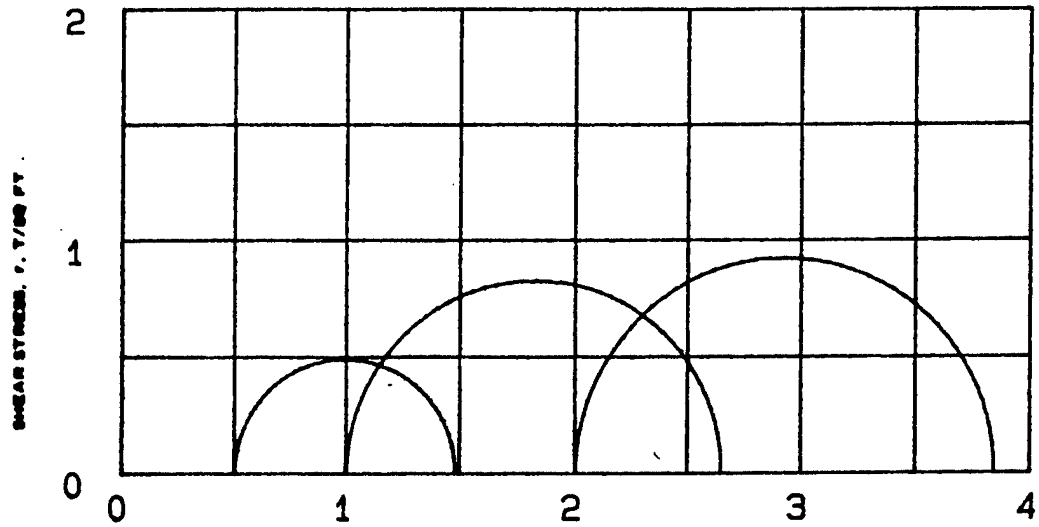
LL = 115	PL = 46	PI = 69	Gs = 2.32	NAT w = %

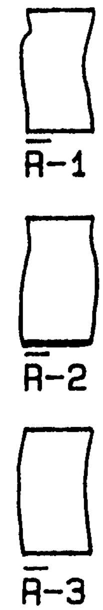
CLASSIFICATION Sandy clay, CH

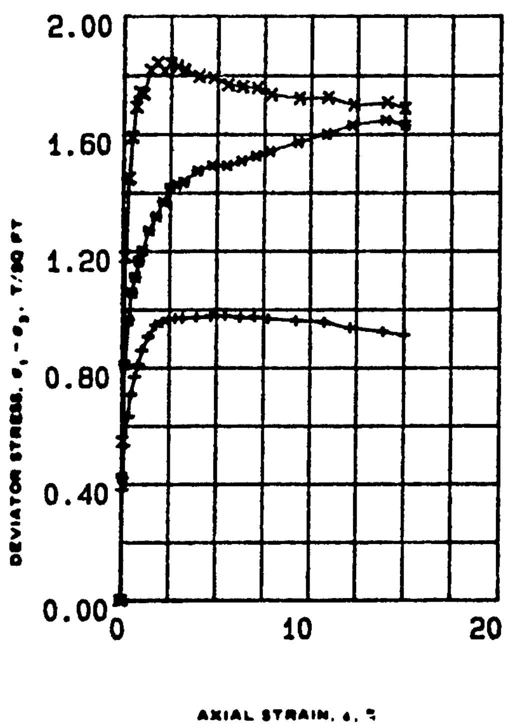
PROJECT	CHASKA; CENCS-IA-90-78-ED-GH
DATE	07-18-90
BORING NO.	90-133 MU
SAMPLE NO.	S-1
DEPTH/ELEV	8'-10'
MRD LAB NO.	90/358

GRADATION CURVE

FIGURE 20







SPECIMEN NO.			1 (+)	2 (x)	3 (X)	
INITIAL	WATER CONTENT, %	w_o	32.8	34.2	40.3	
	DRY DENSITY LB/CU FT	γd_o	86.1	88.2	81.2	
	SATURATION, %	S_o	93	100	100	
	VOID RATIO	e_o	.94	.9	1.06	
BEFORE SHEAR	WATER CONTENT, %	w_c	35	30.6	34.2	
	DRY DENSITY LB/CU FT	γd_c	89.1	93.1	87.5	
	SATURATION, %	S_c	100	100	100	
	VOID RATIO	e_c	.88	.8	.91	
	FINAL BACK PRESSURE, T/SQ FT	u_o	3.383	3.383	3.448	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.5	1	2	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	0.979	1.649	1.843	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	600	1440	210	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	0.911	1.630	1.688	
INITIAL DIAMETER, IN.		D_o	1.4	1.4	1.39	
INITIAL HEIGHT, IN.		H_o	2.97	2.97	2.98	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Sandy clay, CL B-Value 1.0 1.0 1.0

LL 38	PL 20	PI 18	Gs 2.68

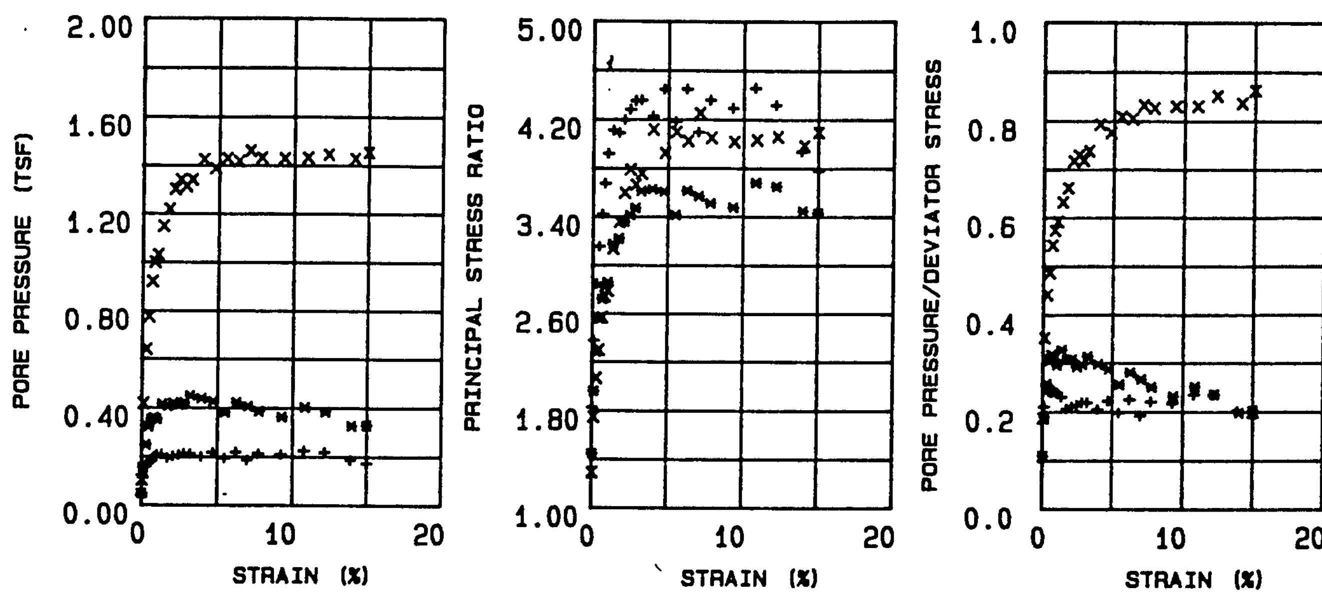
TYPE OF SPECIMEN	UNDISTURBED	TYPE OF TEST	RBAR
PROJECT	CHASKA: CENCS-IA-90-78-ED-GH		
BORING NO	90-133 MU	SAMPLE NO.	S-2
DEPTH ELEV	17'-19'		
LABORATORY	90/358	DATE	08-08-90

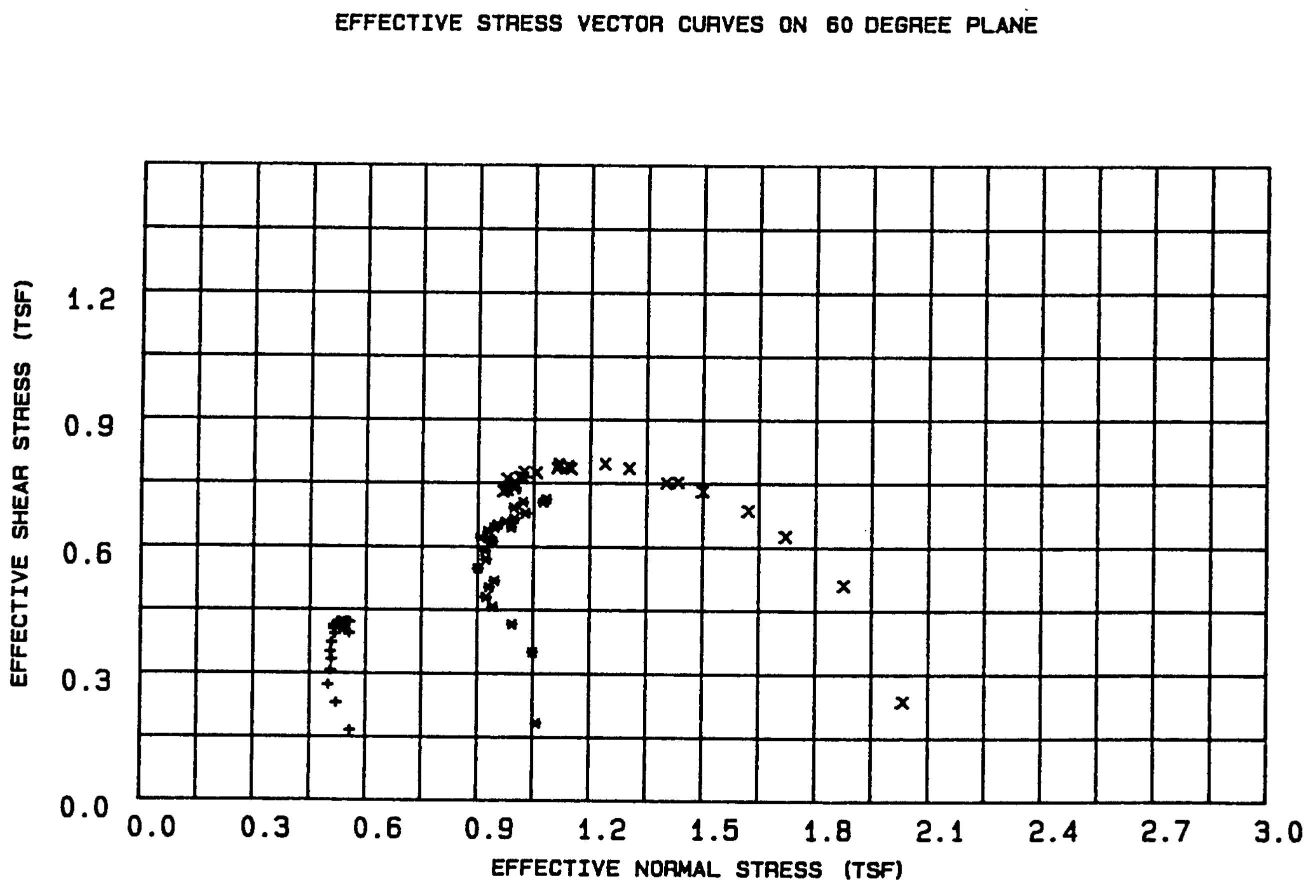
REMARKS:

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2088 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

FIGURE 21





LEGEND

+ = .5 TSF

✱ = 1 TSF

X = 2 TSF

PROJECT	CHASKA: CENCS-IA-90-78-ED-6H
BORING NO.	90-133 MU
SAMPLE NO.	S-2
DEPTH/ELEV	17'-19'
MRD LAB NO.	90/358

FIGURE 22

Table 10 - Triaxial $\bar{R}$ Test Results

Project : CHASKA; CENCS-IA-90-78-ED-GH
Boring Number : 90-133 MU
Sample Number : S-2
Depth : 17'-19'
Confining Pressure : .5 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.05	0.382	0.037	1.825	0.098	0.558	0.165
30	0.14	0.534	0.112	2.376	0.210	0.520	0.230
45	0.31	0.631	0.158	2.843	0.251	0.498	0.272
60	0.48	0.709	0.171	3.153	0.241	0.505	0.306
90	0.67	0.769	0.182	3.419	0.238	0.508	0.332
120	0.83	0.811	0.197	3.672	0.243	0.504	0.350
150	1.03	0.861	0.205	3.920	0.239	0.508	0.372
180	1.36	0.908	0.208	4.111	0.229	0.517	0.392
210	1.74	0.946	0.194	4.088	0.205	0.540	0.408
240	2.10	0.957	0.201	4.198	0.210	0.536	0.413
300	2.46	0.968	0.205	4.282	0.213	0.535	0.418
360	2.81	0.970	0.211	4.354	0.218	0.529	0.419
420	3.20	0.971	0.211	4.359	0.218	0.529	0.419
480	3.94	0.974	0.198	4.225	0.204	0.543	0.420
540	4.70	0.976	0.217	4.446	0.222	0.525	0.421
600	5.47	0.979	0.192	4.180	0.197	0.550	0.422
720	6.23	0.972	0.218	4.448	0.225	0.523	0.420
840	6.99	0.974	0.185	4.092	0.191	0.556	0.420
960	7.76	0.967	0.212	4.361	0.220	0.527	0.417
080	9.26	0.961	0.208	4.293	0.217	0.530	0.415
200	10.77	0.955	0.224	4.459	0.235	0.513	0.412
320	12.15	0.935	0.218	4.318	0.234	0.514	0.404
440	13.89	0.923	0.185	3.932	0.201	0.544	0.399
524	15.00	0.911	0.171	3.773	0.188	0.555	0.393

Table 11 - Triaxial $\bar{R}$ Test Results

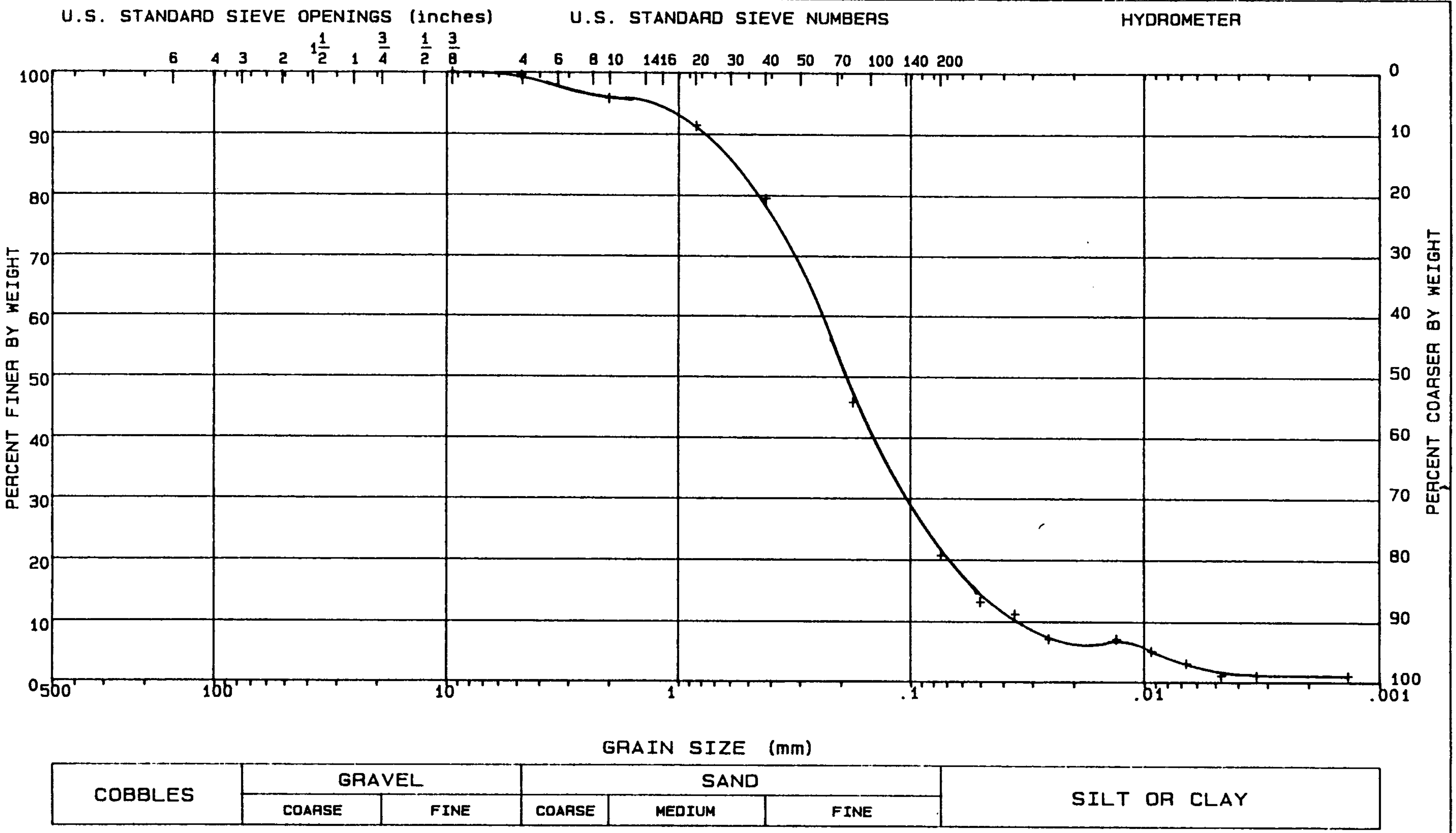
Project : CHASKA; CENCS-IA-90-78-ED-GH
Boring Number : 90-133 MU
Sample Number : S-2
Depth : 17'-19'
Confining Pressure : 1 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.05	0.423	0.046	1.443	0.109	1.059	0.182
30	0.14	0.811	0.153	1.958	0.189	1.048	0.350
45	0.31	0.964	0.247	2.281	0.257	0.992	0.416
60	0.48	1.058	0.322	2.560	0.305	0.940	0.457
90	0.67	1.112	0.353	2.720	0.318	0.922	0.480
120	0.84	1.167	0.359	2.821	0.308	0.930	0.504
150	1.03	1.202	0.353	2.858	0.295	0.944	0.519
180	1.37	1.271	0.415	3.173	0.327	0.900	0.549
210	1.75	1.320	0.405	3.218	0.307	0.922	0.570
240	2.11	1.370	0.419	3.358	0.307	0.920	0.591
300	2.47	1.418	0.412	3.412	0.291	0.939	0.612
360	2.83	1.429	0.422	3.472	0.296	0.932	0.617
420	3.22	1.438	0.449	3.611	0.313	0.907	0.621
480	3.96	1.476	0.438	3.626	0.297	0.927	0.637
540	4.73	1.494	0.426	3.605	0.286	0.944	0.645
600	5.50	1.493	0.381	3.411	0.255	0.989	0.645
720	6.27	1.510	0.422	3.613	0.280	0.952	0.652
840	7.04	1.527	0.405	3.566	0.266	0.973	0.659
960	7.80	1.543	0.385	3.508	0.250	0.997	0.666
1080	9.32	1.574	0.363	3.472	0.231	1.027	0.679
1200	10.83	1.602	0.402	3.679	0.251	0.995	0.692
1320	12.22	1.632	0.383	3.647	0.235	1.021	0.705
1440	13.98	1.649	0.325	3.443	0.197	1.083	0.712
1517	15.00	1.630	0.328	3.428	0.202	1.075	0.704

Table 12 - Triaxial $\bar{R}$ Test Results

Project : CHASKA; CENCS-IA-90-78-ED-GH
Boring Number : 90-133 MU
Sample Number : S-2
Depth : 17'-19'
Confining Pressure : 2 TSF

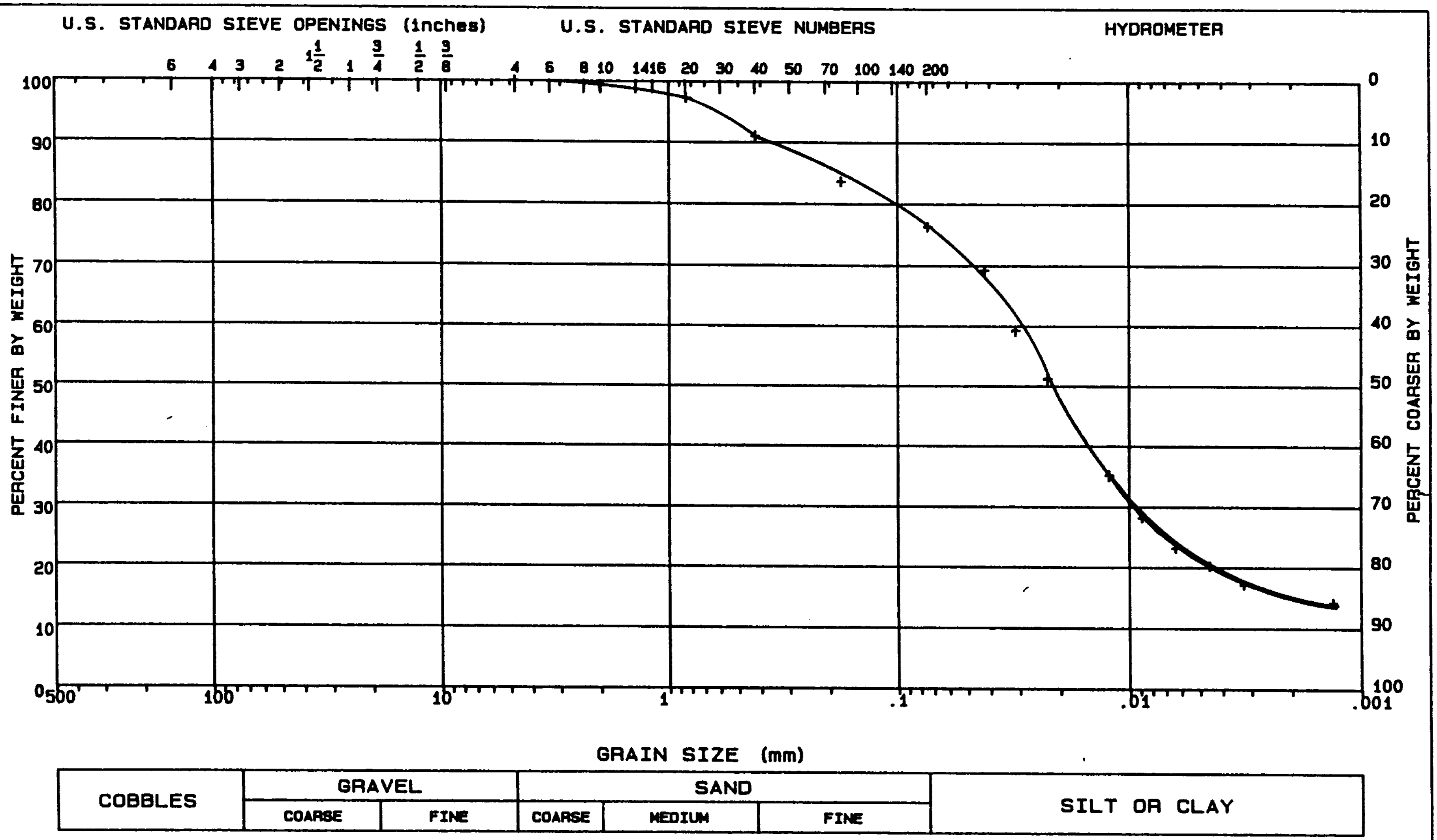
Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.05	0.547	0.102	1.288	0.187	2.033	0.236
30	0.14	1.181	0.416	1.746	0.352	1.876	0.510
45	0.31	1.450	0.639	2.065	0.441	1.720	0.626
60	0.48	1.591	0.774	2.297	0.487	1.620	0.686
90	0.68	1.694	0.920	2.568	0.543	1.499	0.731
120	0.84	1.743	0.999	2.742	0.574	1.433	0.752
150	1.04	1.738	1.029	2.789	0.592	1.401	0.750
180	1.38	1.818	1.148	3.135	0.632	1.302	0.785
210	1.76	1.843	1.218	3.355	0.661	1.238	0.795
240	2.13	1.815	1.301	3.595	0.717	1.148	0.783
300	2.49	1.840	1.340	3.789	0.729	1.115	0.794
360	2.85	1.829	1.313	3.661	0.718	1.140	0.789
420	3.24	1.818	1.340	3.756	0.738	1.110	0.785
480	3.99	1.796	1.424	4.116	0.793	1.021	0.775
540	4.76	1.791	1.387	3.922	0.775	1.056	0.773
600	5.53	1.768	1.429	4.095	0.809	1.009	0.763
720	6.30	1.762	1.417	4.021	0.804	1.019	0.761
840	7.08	1.757	1.460	4.253	0.832	0.975	0.758
960	7.85	1.734	1.431	4.045	0.826	0.998	0.748
080	9.37	1.722	1.429	4.014	0.830	0.997	0.743
200	10.90	1.725	1.431	4.030	0.830	0.996	0.745
320	12.29	1.699	1.444	4.058	0.851	0.977	0.733
440	14.06	1.708	1.427	3.982	0.836	0.996	0.737
510	15.00	1.688	1.454	4.094	0.862	0.965	0.729



LL =	PL =	PI =	Gs = 2.68	NAT w = %	PROJECT	CHASKA; CENCS-IA-90-78-ED-GH
CLASSIFICATION Non-plastic. Silty sand, SM					DATE	08-10-90
					BORING NO.	90-133 MU
					SAMPLE NO.	S-2 (TOP)
GRADATION CURVE					DEPTH/ELEV	17'-19'
					MRD LAB NO.	90/358

FIGURE 23

FIGURE D-77



LL = 38	PL = 20	PI = 18	Gs = 2.66	NAT w = %

CLASSIFICATION Trimming from Triaxial R-Bar Tests.
Sandy clay, CL

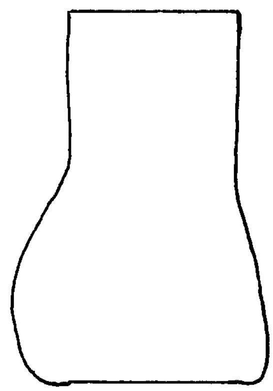
GRADATION CURVE

PROJECT	CHASKA; CENCS-IA-90-78-ED-GH
DATE	08-10-90
BORING NO.	90-133 MU
SAMPLE NO.	S-2 (BOT.)
DEPTH/ELEV	17'-19'
MRD LAB NO.	90/358

FIGURE 24

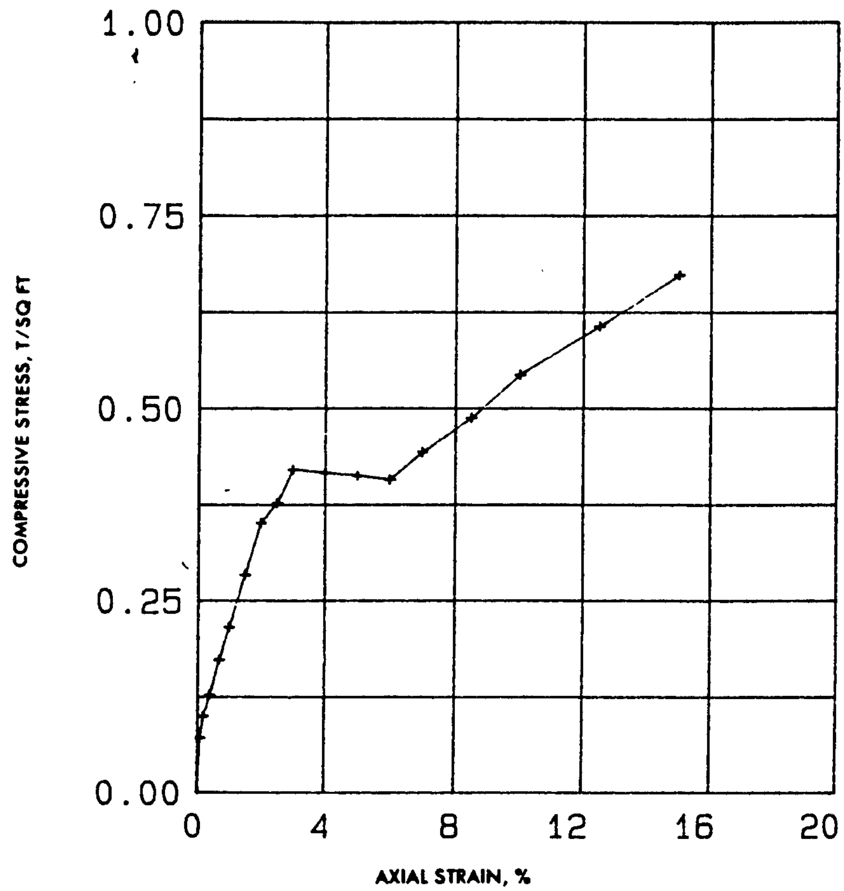
FIGURE D-78

FAILURE SKETCHES



☐ CONTROLLED STRESS

☒ CONTROLLED STRAIN



TEST NO.						
TYPE OF SPECIMEN UNDISTURBED						
INITIAL	WATER CONTENT	w_o	23.0 %	%	%	%
INITIAL	VOID RATIO	e_o	0.63			
INITIAL	SATURATION	S_o	98 %	%	%	%
INITIAL	DRY DENSITY, LB/CU FT	γ_d	103.2			
TIME TO FAILURE, MIN		t_f	35.0			
UNCONFINED COMPRESSIVE STRENGTH, T/SQ FT		q_u	0.67			
UNDRAINED SHEAR STRENGTH, T/SQ FT		s_u				
SENSITIVITY RATIO		S_t				
INITIAL SPECIMEN DIAMETER, IN		D_o	1.40			
INITIAL SPECIMEN HEIGHT, IN.		H_o	3.00			

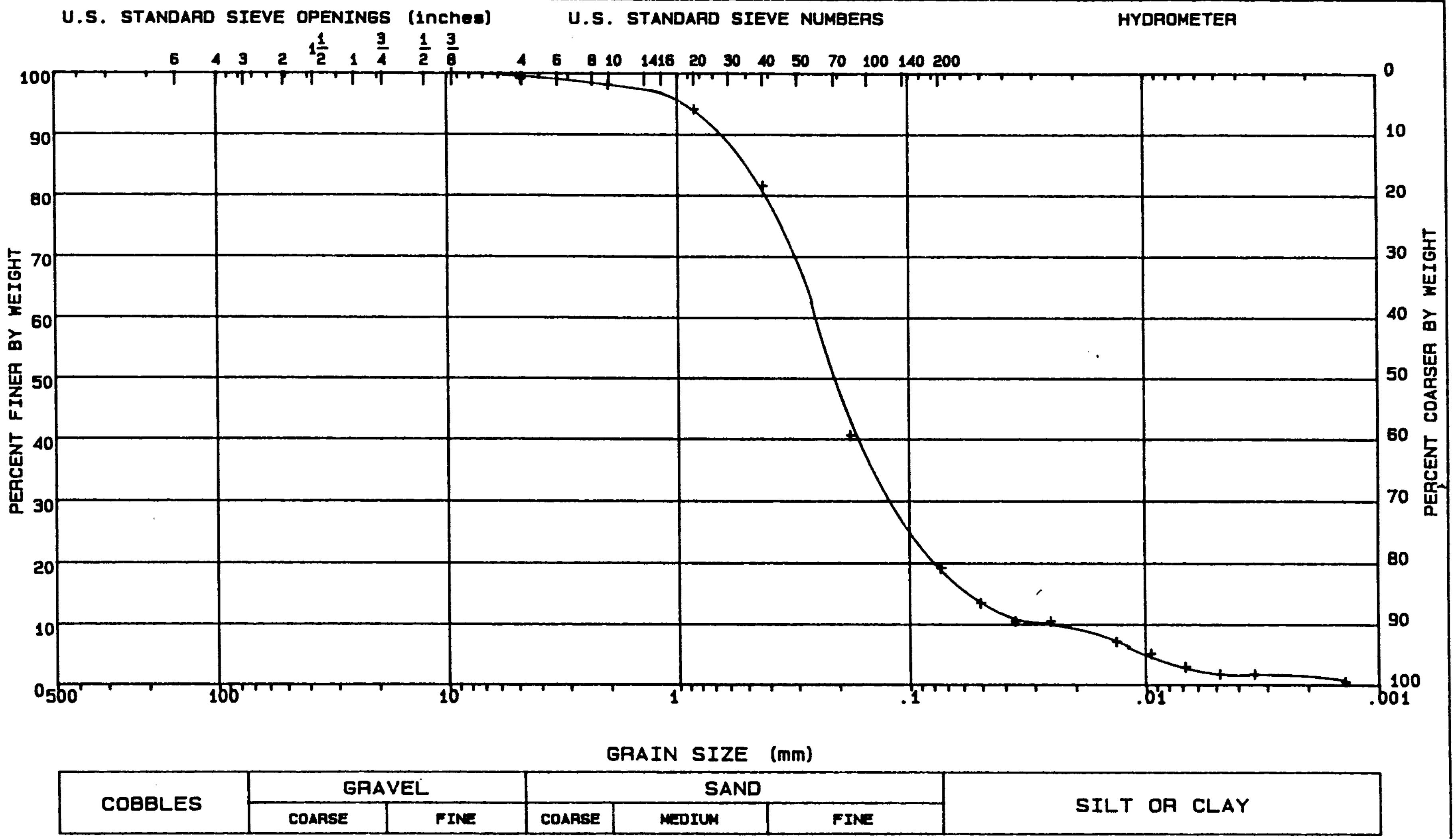
CLASSIFICATION Clayey sand, SC

LL 31	PL 15	PI 15	G_s 2.7 EST.

REMARKS Brown. Too brittle for Torvane, non-calcareous.

PROJECT	CHASKA; CENCS-IA-90-78-ED-GH		
AREA	MRD LAB NO. : 90/358		
BORING NO.	90-133 MU	SAMPLE NO.	S-3
DEPTH EL	22'-24'	DATE	08-17-90

UNCONFINED COMPRESSION TEST REPORT



LL =	PL =	PI =	Gs = 2.64	NAT w = %	PROJECT	CHASKA; CENCS-IA-90-78-ED-GH
CLASSIFICATION	Non-plastic. Silty sand, SM.				DATE	08-23-90
					BORING NO.	90-133 MU
					SAMPLE NO.	S-3 (TOP)
GRADATION CURVE					DEPTH/ELEV	22'-24'
					MRD LAB NO.	90/358

FIGURE 26

FIGURE D-80

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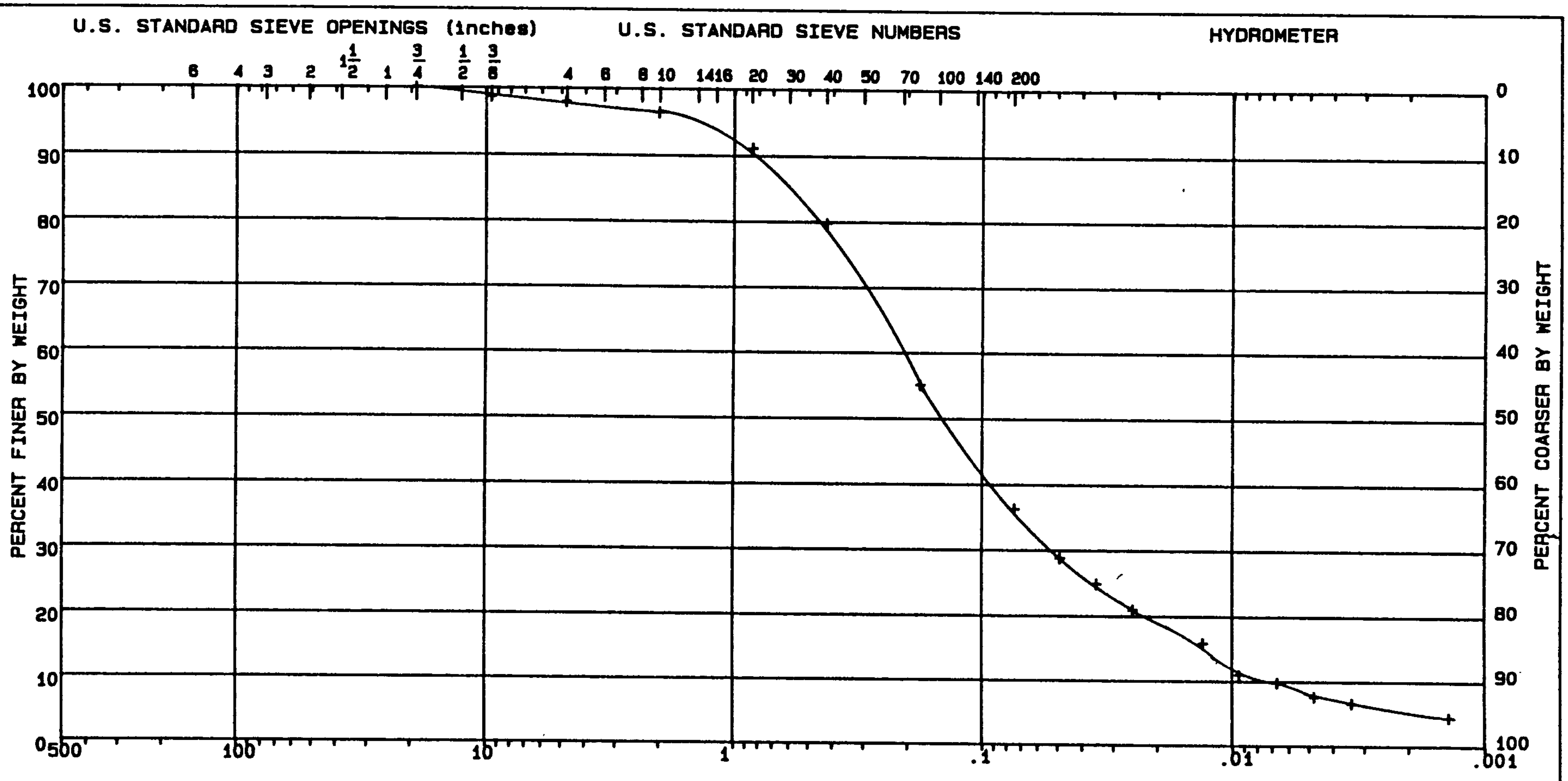


GRAIN SIZE (mm)

COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

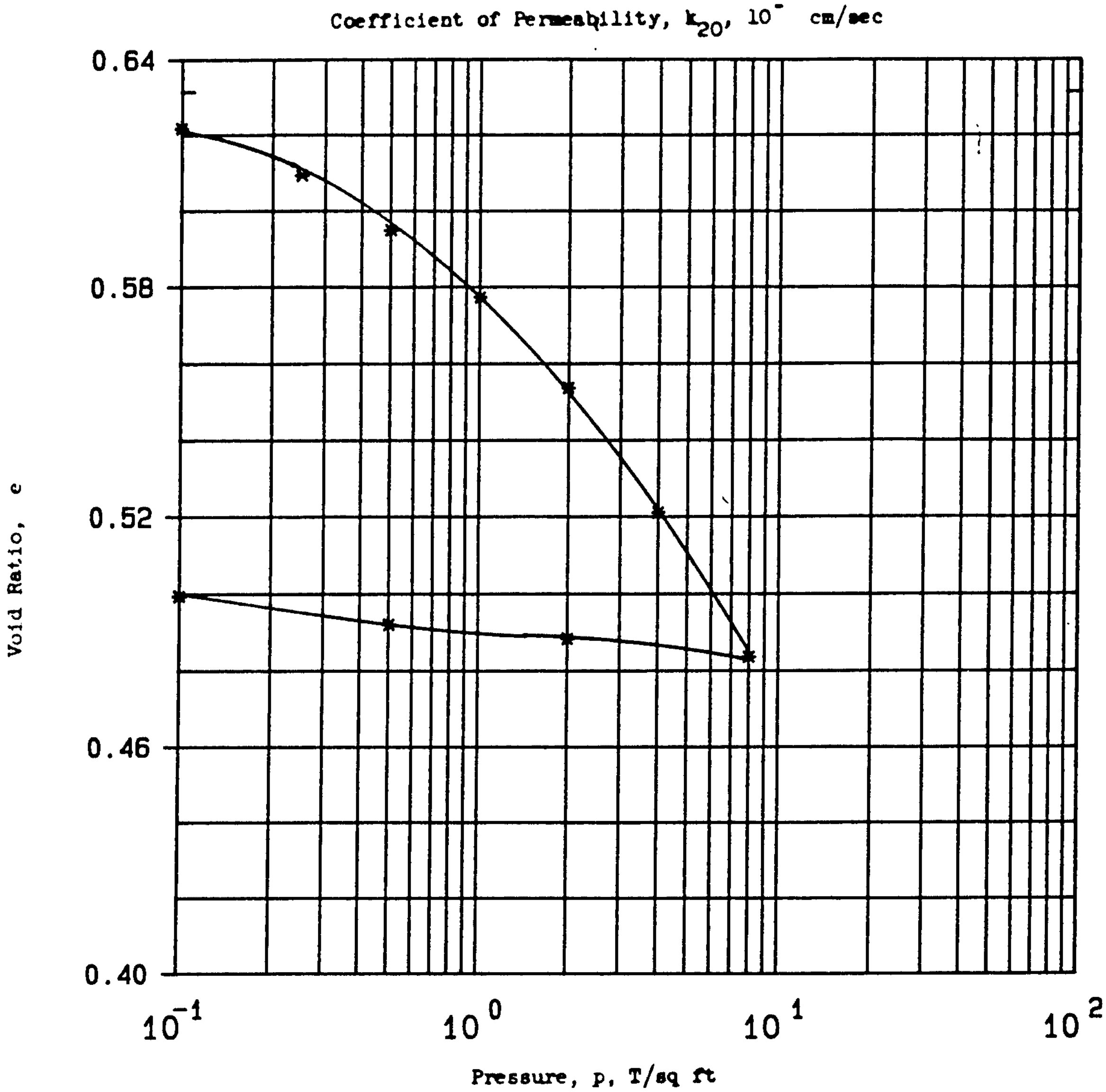
LL = 31	PL = 15	PI = 16	Gs = 2.62	NAT w = %

CLASSIFICATION Clayey sand, SC. Trimmings from unconfined test.

GRADATION CURVE

PROJECT	CHASKA; CENCS-IA-90-78-ED-GH
DATE	08-23-90
BORING NO.	90-133 MU
SAMPLE NO.	S-3 (BOT.)
DEPTH/ELEV	22'-24'
MRD LAB NO.	90/358

FIGURE 27



Type of Specimen UNDISTURBED			
Diam 2.5 in.		Ht .75 in.	
Overburden Pressure, p_o T/sq ft			
Preconsol. Pressure, p_c T/sq ft			
Compression Index, C_c			
Classification Clayey sand, SC			
LL	33	G_s	2.66
PL	17	D_{10}	
Remarks Grey-brown. Too brittle			
for Torvane, non-calcareous.			

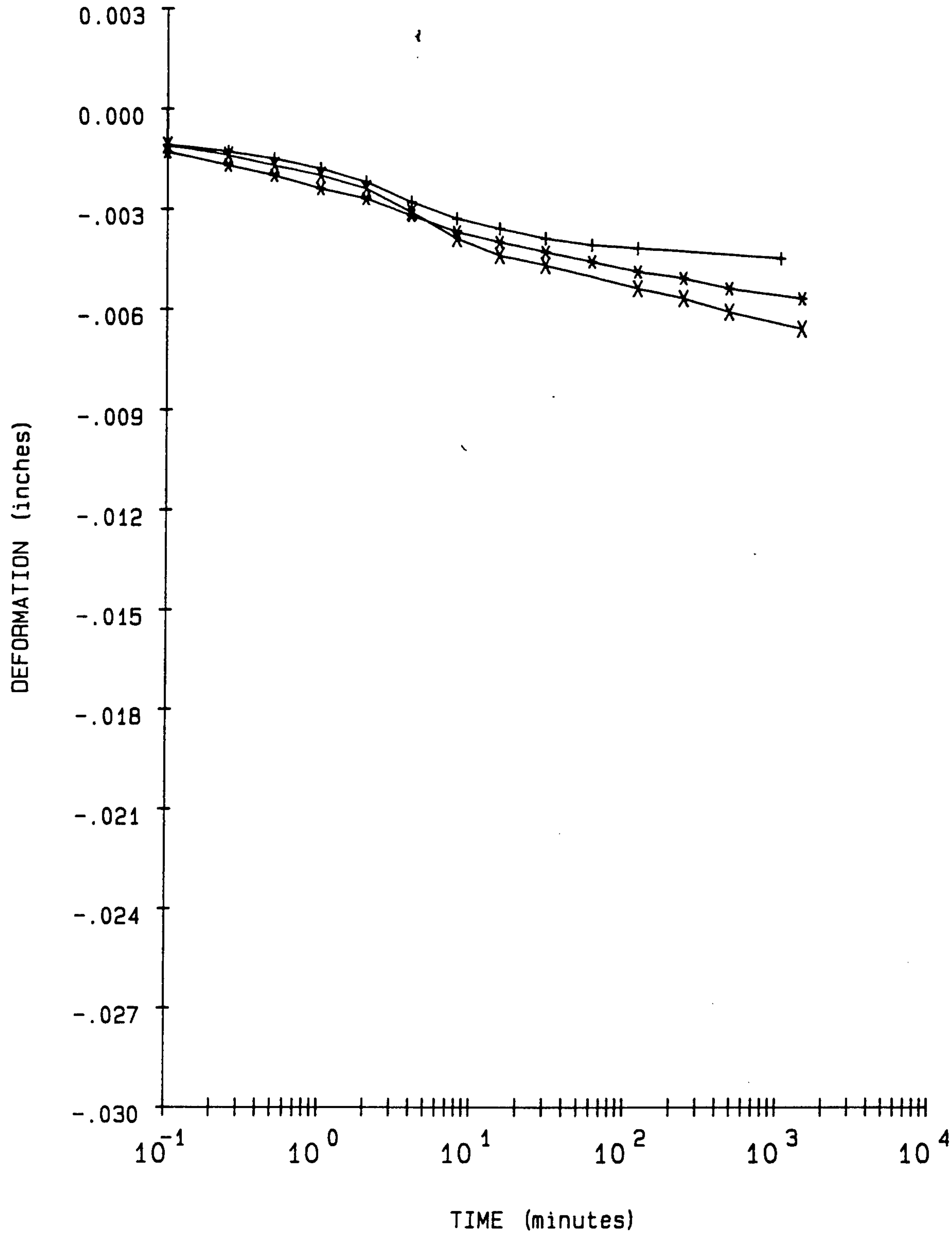
	Before Test		After Test
Water Content, w_o	22.6 %	w_f	17.8 %
Void Ratio, e_o	0.63	e_f	0.50
Saturation, S_o	95 %	S_f	95 %
Dry Density, γ_d	101.7 lb/ft^3		
k_{20} at e_o = × 10^{-} cm/sec			

Project	CHASKA; CENCS-IA-90-78-ED-GH		
Area	MRD LAB NO. 90/358		
Boring No.	90-134 MU	Sample No.	S-1
Depth El	3'-4.3'	Date	08-07-90

CONSOLIDATION TEST REPORT

ENG FORM 1 MAY 63 2090 PREVIOUS EDITIONS ARE OBSOLETE.

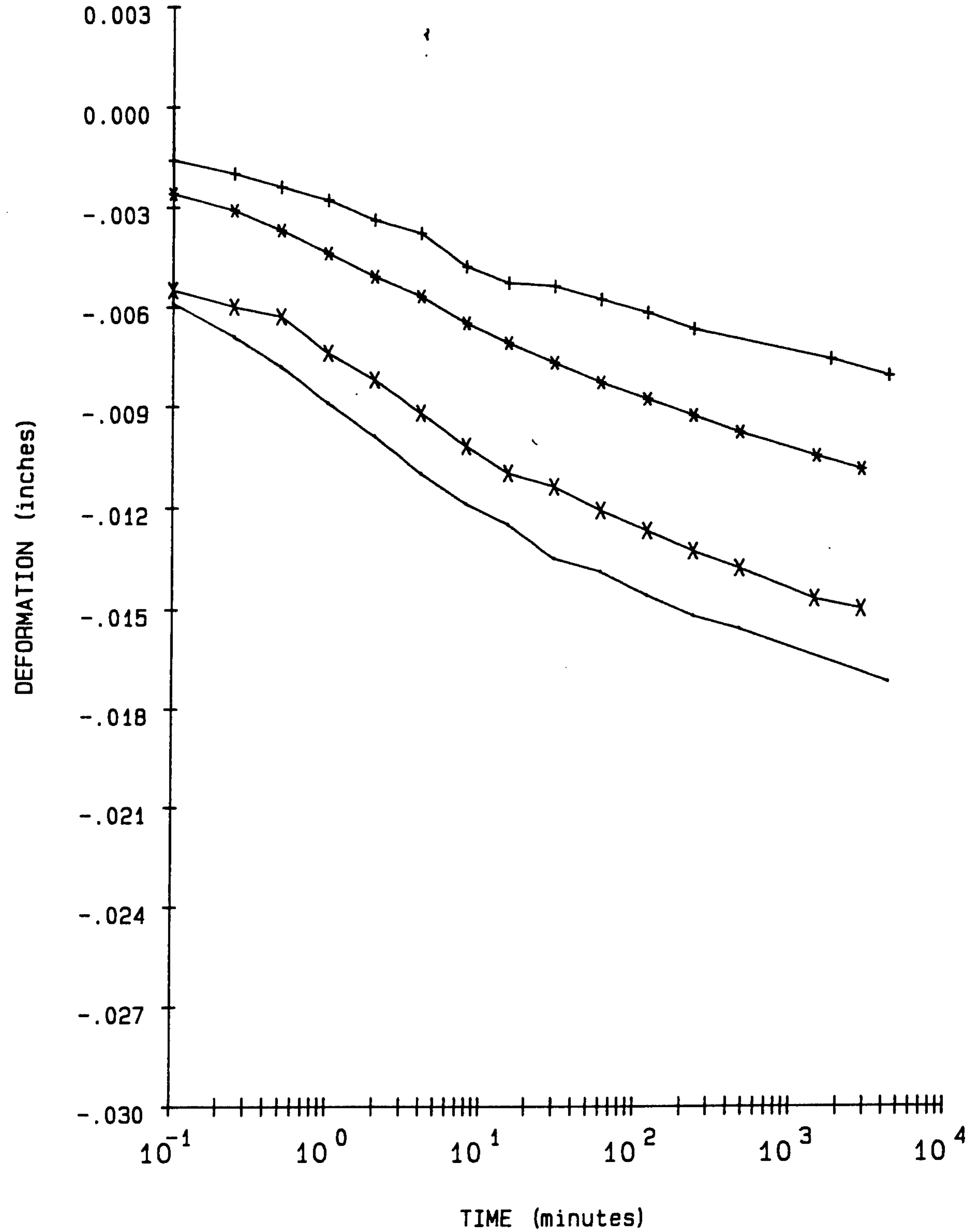
Figure 28



LEGEND	
+ = .1 TSF Wet	
* = .25 TSF	
X = .5 TSF	

PROJECT	CHASKA; CENCS-IA-90-78-ED-GH
BORING NO.	90-134 MU
SAMPLE NO.	S-1
DEPTH/ELEV	3'-4.3'
MRD LAB NO.	90/358

FIGURE 29

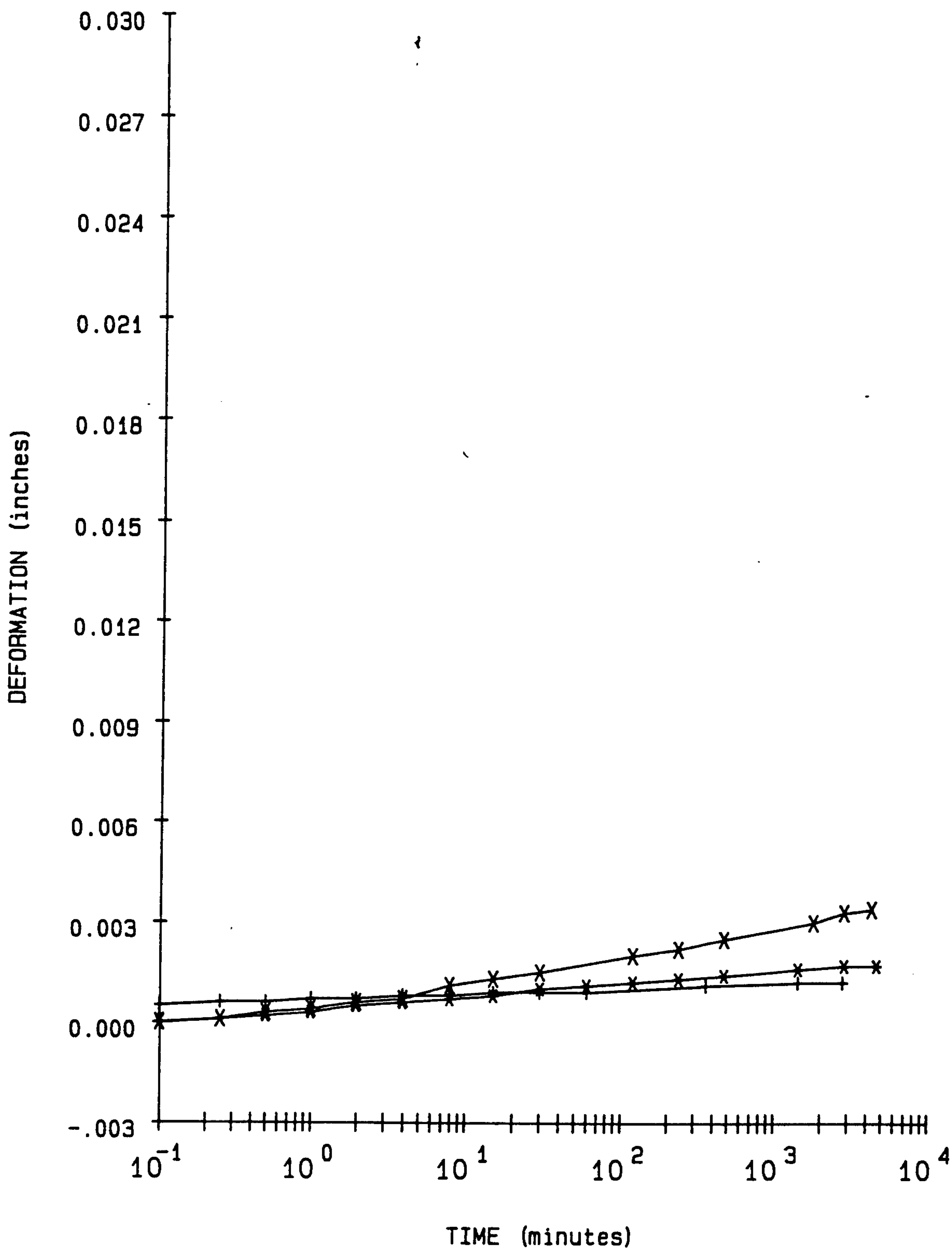


LEGEND

+ = 1 TSF
* = 2 TSF
X = 4 TSF
- = 8 TSF

PROJECT	CHASKA; CENCS-IA-90-78-ED-GH
BORING NO.	90-134 MU
SAMPLE NO.	S-1
DEPTH/ELEV	3'-4.3'
MRD LAB NO.	90/358

FIGURE 30



LEGEND

+ = 2 TSF Rebound
* = .5 TSF Rebound
X = .1 TSF Rebound

PROJECT	CHASKA; CENCS-IA-90-78-ED-GH
BORING NO.	90-134 MU
SAMPLE NO.	S-1
DEPTH/ELEV	3'-4.3'
MRD LAB NO.	90/358

FIGURE 31

Consolidation Test Data

Project CHASKA; CENCS-IA-90-78-ED-GH

Boring No. 90-134 MU
Sample No. S-1
Depth/Elev 3'-4.3'
MRD Lab No. 90/358

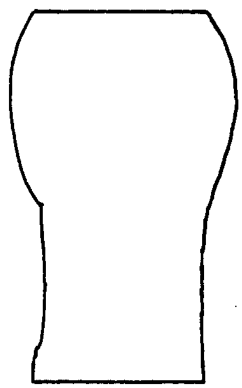
Gs = 2.66
eo = 0.631
0.42eo = 0.265

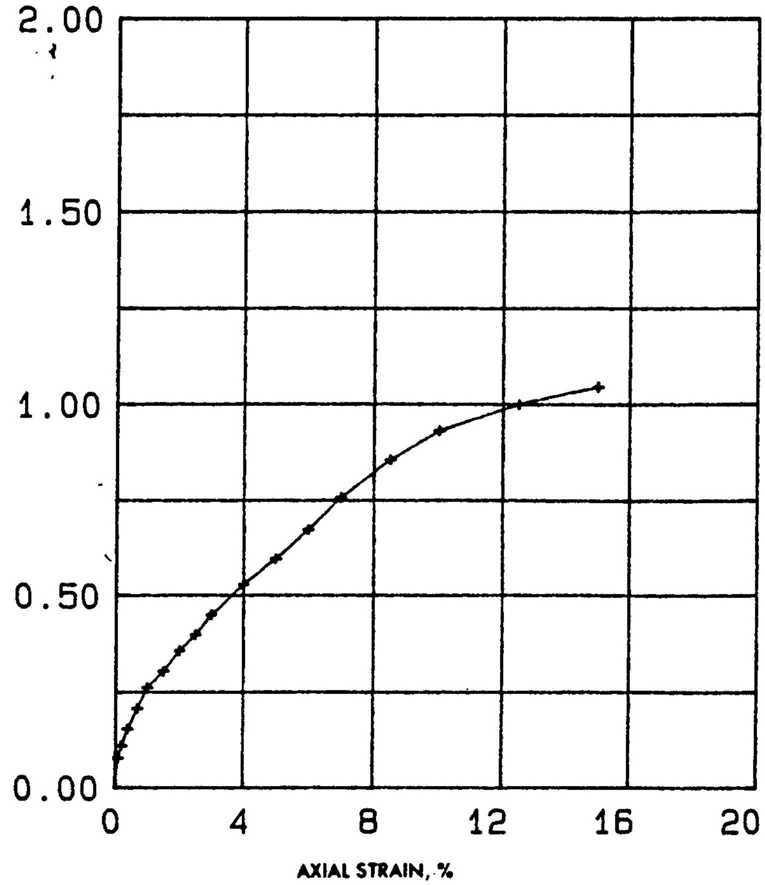
Water Content (%)	Dry Weight (gms)	Dry Density (PCF)	Void Ratio	Pressure (TSF)	Saturation (%)
22.6	98.4	101.7	0.631		95.2
17.8	98.4	102.4	0.622	0.10	76.2
17.8	98.4	103.1	0.609	0.25	77.7
17.8	98.4	104.1	0.595	0.50	79.6
17.8	98.4	105.2	0.577	1.00	82.0
17.8	98.4	106.8	0.554	2.00	85.5
17.8	98.4	109.1	0.521	4.00	90.9
17.8	98.4	111.9	0.484	8.00	97.9
17.8	98.4	111.5	0.488	2.00	97.0
17.8	98.4	111.2	0.492	0.50	96.2
17.8	98.4	110.7	0.499	0.10	94.8

Axial Strain (%)	Void Ratio
1	0.615
2	0.599
3	0.582
4	0.566
5	0.550
6	0.534
7	0.517
8	0.501
9	0.485
10	0.468
11	0.452
12	0.436

8

FAILURE SKETCHES





[ ] CONTROLLED STRESS

[X] CONTROLLED STRAIN

TEST NO.						
TYPE OF SPECIMEN	UNDISTURBED					
INITIAL	WATER CONTENT	w_o	20.8 %	%	%	%
INITIAL	VOID RATIO	e_o	0.66			
INITIAL	SATURATION	S_o	85 %	%	%	%
INITIAL	DRY DENSITY, LB/CU FT	γ_d	101.5			
TIME TO FAILURE, MIN		t_f	38.0			
UNCONFINED COMPRESSIVE STRENGTH, T/SQ FT		q_u	1.05			
UNDRAINED SHEAR STRENGTH, T/SQ FT		s_u				
SENSITIVITY RATIO		S_t				
INITIAL SPECIMEN DIAMETER, IN		D_o	2.89			
INITIAL SPECIMEN HEIGHT, IN.		H_o	6.55			

CLASSIFICATION Clayey sand, SC

LL 33	PL 17	PI 16	G_s 2.7 EST.

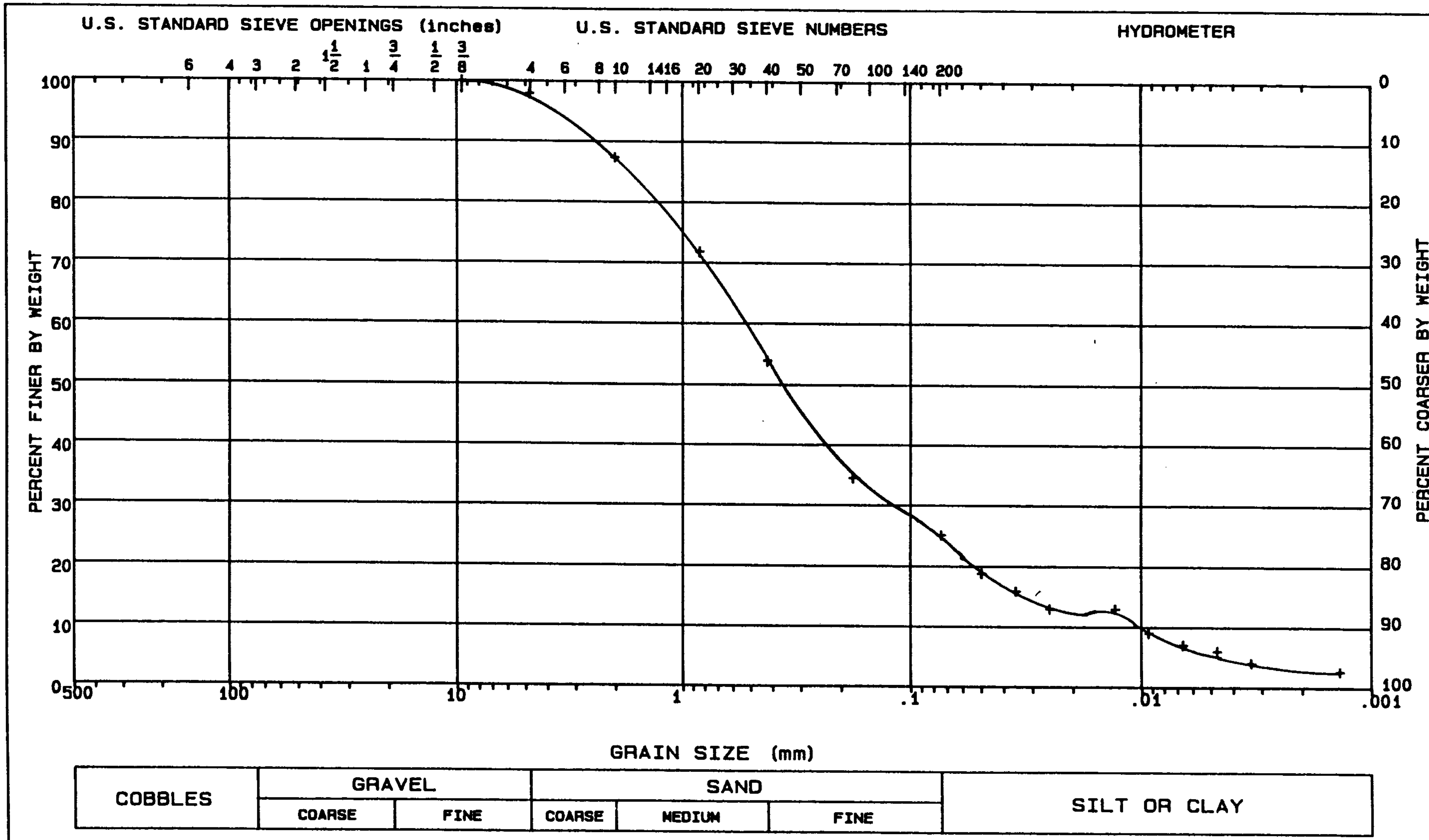
REMARKS Grey-brown. Too brittle for Torvane, non-calcareous.

PROJECT	CHASKA; CENCS-IA-90-78-ED-GH
AREA	MRD LAB NO. : 90/358
BORING NO.	90-134 MU
SAMPLE NO.	S-1
DEPTH EL	3'-4.3'
DATE	07-30-90

UNCONFINED COMPRESSION TEST REPORT

ENG FORM 1 JUN 65 3659 (EM 1110-2-1906) (TRANSLUCENT) GPO : 1966 OF—214-946 PLATE XI-2

FIGURE D-87



LL = 33	PL = 17	PI = 16	Gs = 2.66	NAT w = %

CLASSIFICATION Clayey sand SC

GRADATION CURVE

PROJECT	CHASKA; CENCS-IA-90-78-ED-GH
DATE	08-03-90
BORING NO.	90-134 MU
SAMPLE NO.	S-1
DEPTH/ELEV	3'-4.3'
MRD LAB NO.	90/358

FIGURE 33

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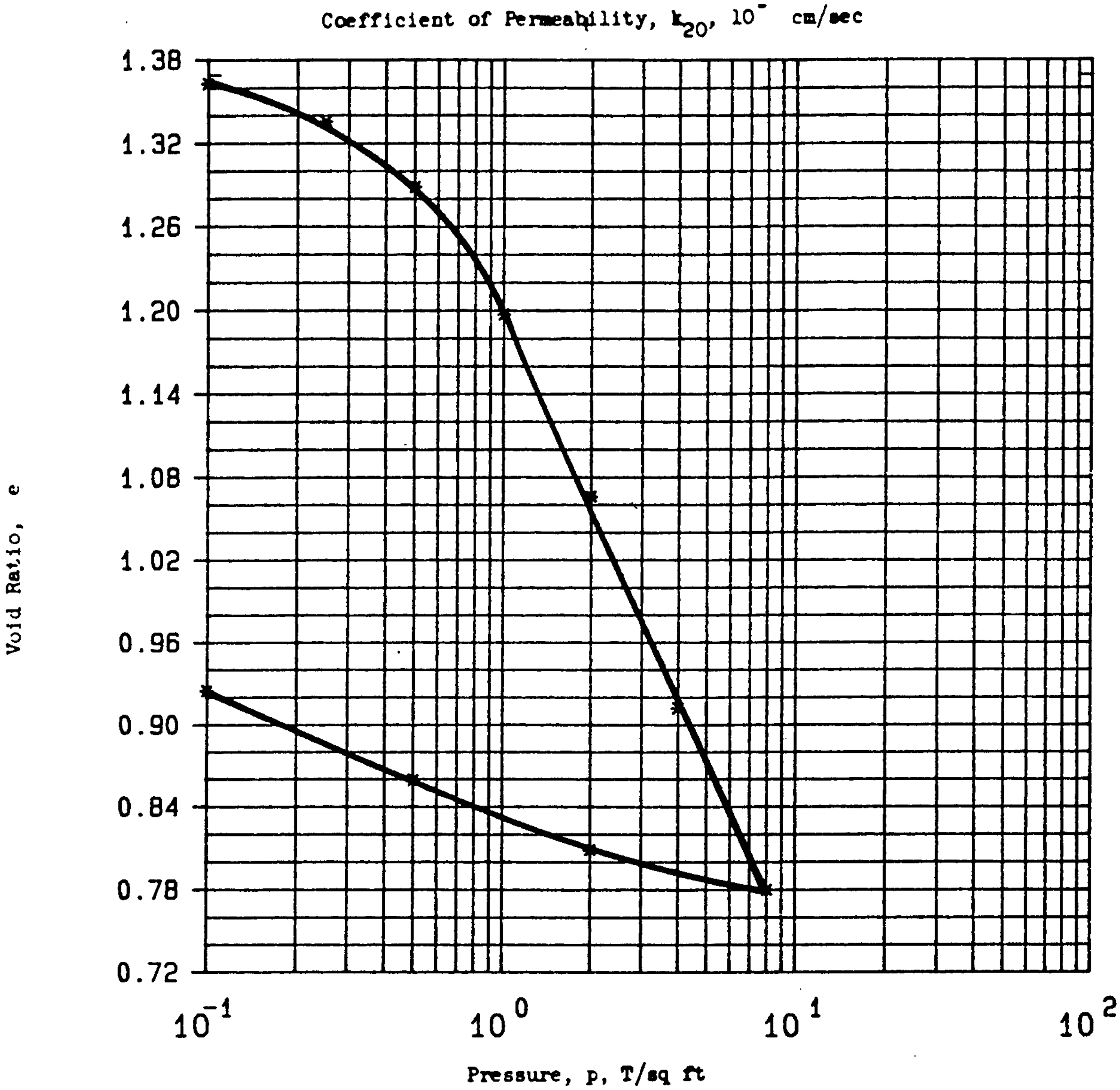


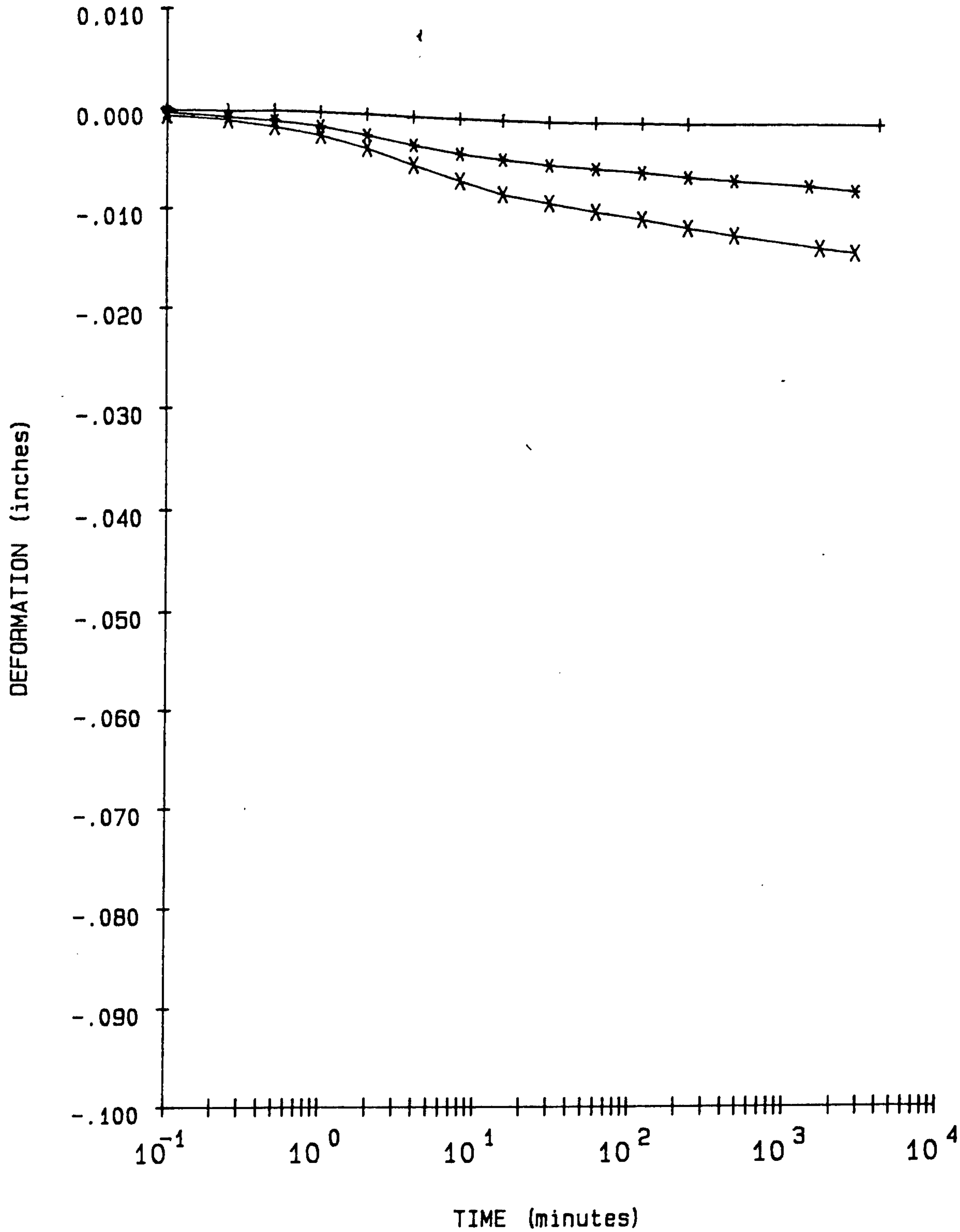
Type of Specimen	UNDISTURBED		Before Test		After Test	
Diam 2.5 in.	Ht .75 in.		Water Content, w_o	50.4 %	w_f	37.2 %
Overburden Pressure, p_o	T/sq ft		Void Ratio, e_o	1.37	e_f	0.92
Preconsol. Pressure, p_c	T/sq ft		Saturation, S_o	98 %	S_f	100 %
Compression Index, C_c			Dry Density, γ_d	69.8 lb/ft^3		
Classification Clayey sand, ~~CL~~ SC			k_{20} at e_o =	x 10^{-} cm/sec		
LL 27	G_s 2.65		Project	CHASKA; CENCS-IA-90-78-ED-GH		
PL 13	D_{10}					
Remarks Black and gray. Torvane= 0.35 TSF. Slightly organic.			Area	MRD LAB NO. 90/358		
			Boring No.	90-134 MU	Sample No.	S-2
			Depth El	8'-10'	Date	09-07-90

CONSOLIDATION TEST REPORT

ENG FORM 1 MAY 63 2090 PREVIOUS EDITIONS ARE OBSOLETE.

Figure 1

FIGURE D-89

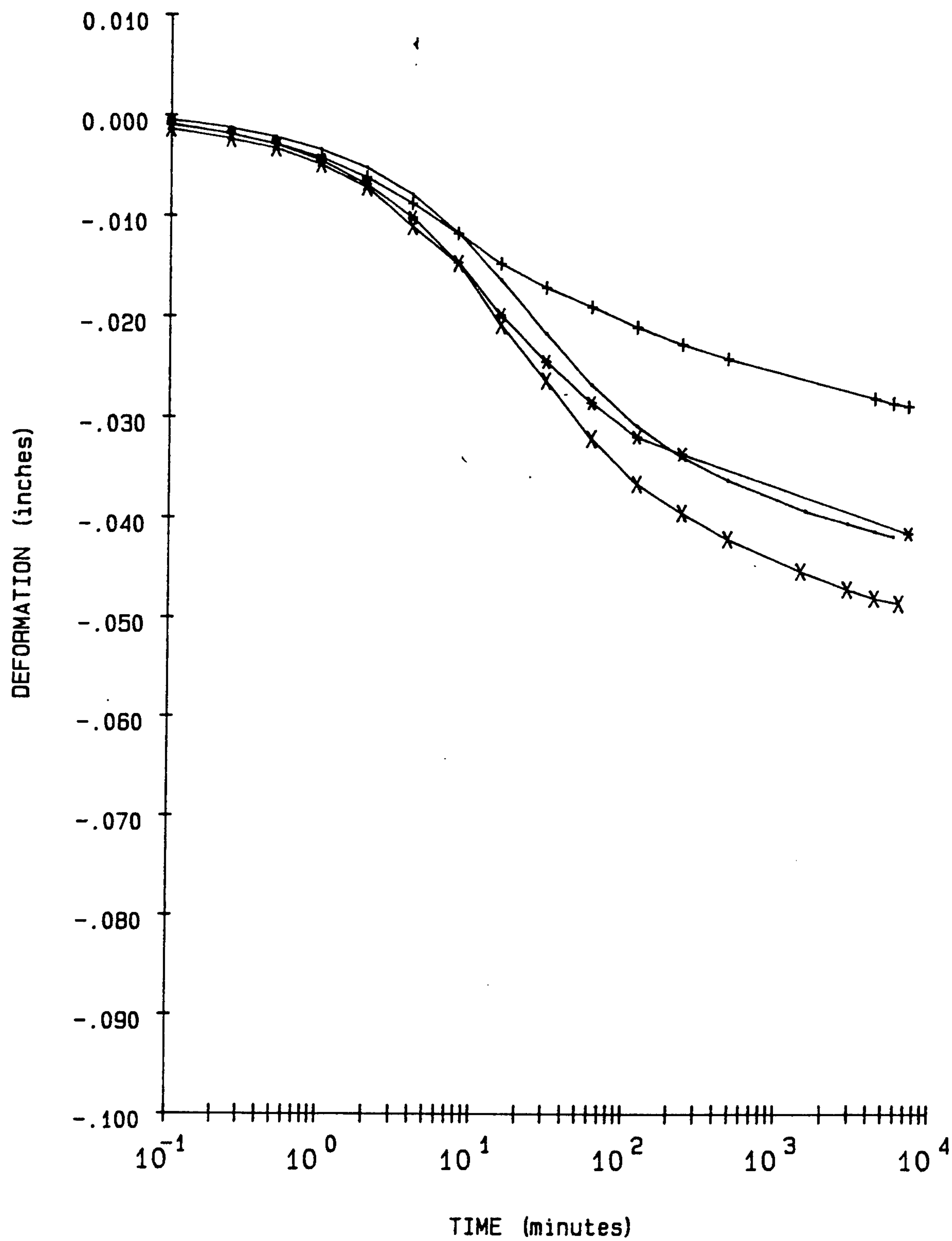


LEGEND			
+ =	.1	TSF	Wet
* =	.25	TSF	
X =	.5	TSF	

PROJECT	CHASKA: CENCS-IA-90-78-ED-GH
BORING NO.	90-134 MU
SAMPLE NO.	S-2
DEPTH/ELEV	8'-10'
MRD LAB NO.	90/358

FIGURE 2

FIGURE D-90

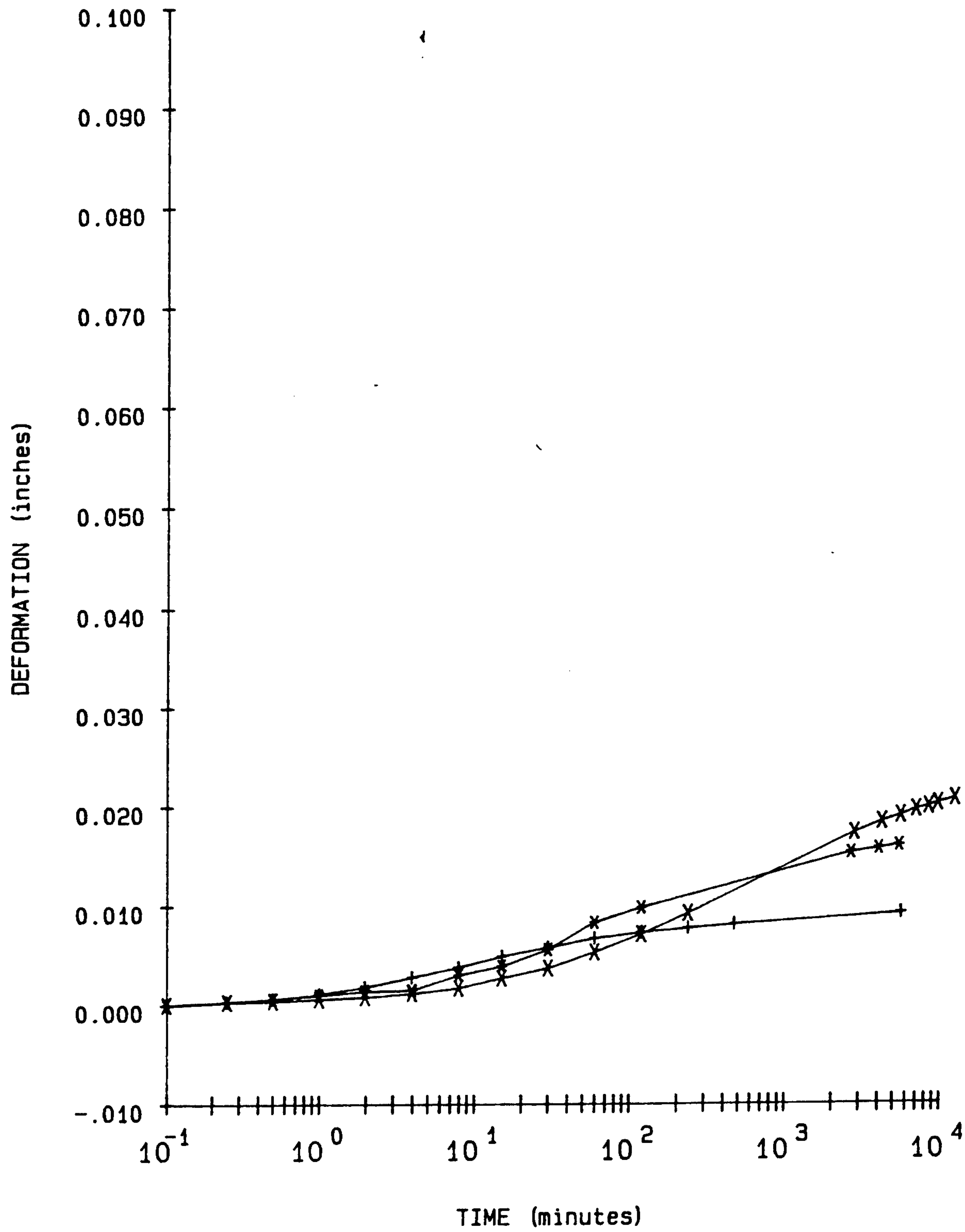


LEGEND

+ = 1 TSF
* = 2 TSF
X = 4 TSF
- = 8 TSF

PROJECT	CHASKA: CENCS-IA-90-78-ED-GH
BORING NO.	90-134 MU
SAMPLE NO.	S-2
DEPTH/ELEV	8'-10'
MRD LAB NO.	90/358

FIGURE 3



LEGEND		
+ = 2	TSF	Rebound
* = .5	TSF	Rebound
X = .1	TSF	Rebound

PROJECT	CHASKA: CENCS-IA-90-78-ED-GH
BORING NO.	90-134 MU
SAMPLE NO.	S-2
DEPTH/ELEV	8'-10'
MRD LAB NO.	90/358

FIGURE 4

Consolidation Test Data

Project CHASKA; CENCS-IA-90-78-ED-GH

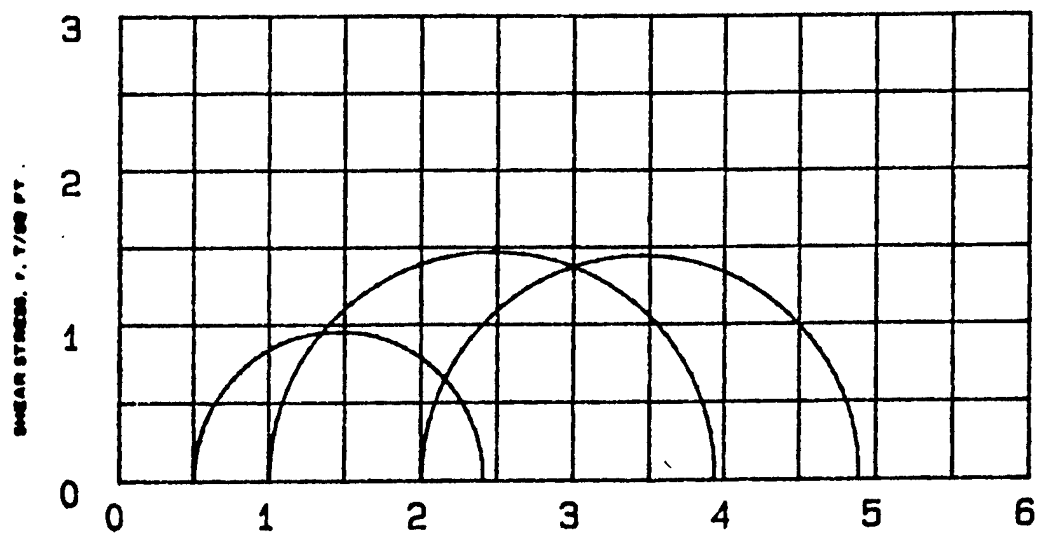
Boring No. 90-134 MU
Sample No. S-2
Depth/Elev 8'-10'
MRD Lab No. 90/358

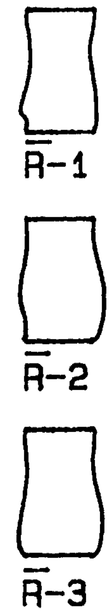
Gs = 2.65
eo = 1.369
0.42eo = 0.575

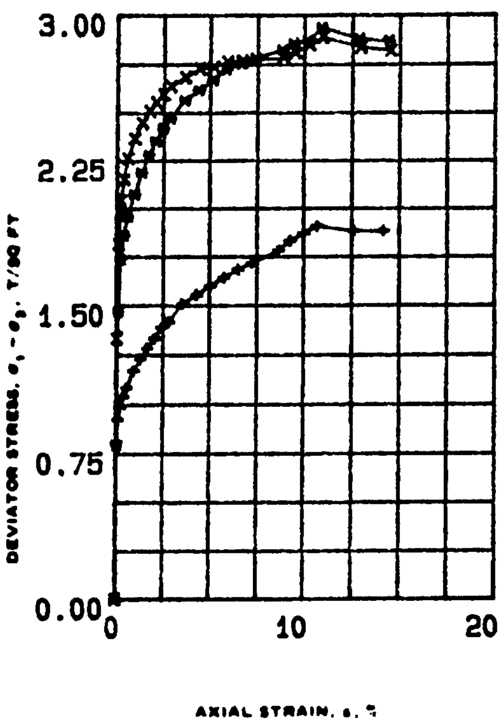
Water Content (%)	Dry Weight (gms)	Dry Density (PCF)	Void Ratio	Pressure (TSF)	Saturation (%)
50.4	67.5	69.8	1.369		97.6
37.2	67.5	70.0	1.363	0.10	72.4
37.2	67.5	70.8	1.335	0.25	73.9
37.2	67.5	72.3	1.288	0.50	76.6
37.2	67.5	75.3	1.197	1.00	82.4
37.2	67.5	80.1	1.065	2.00	92.6
37.2	67.5	86.5	0.912	4.00	100.0
37.2	67.5	92.9	0.780	8.00	100.0
37.2	67.5	91.4	0.809	2.00	100.0
37.2	67.5	88.9	0.859	0.50	100.0
37.2	67.5	85.9	0.925	0.10	100.0

Axial Strain (%)	Void Ratio
1	1.346
2	1.322
3	1.298
4	1.275
5	1.251
6	1.227
7	1.203
8	1.180
9	1.156
10	1.132
11	1.109
12	1.085
13	1.061
14	1.038
15	1.014
16	0.990
17	0.967
18	0.943
19	0.919
20	0.895

92







SPECIMEN NO.			1 (+)	2 (✱)	3 (X)
INITIAL	WATER CONTENT, %	w_o	21	19.6	26.9
	DRY DENSITY LB/CU FT	γ_{d_o}	100.2	102.7	94.2
	SATURATION, %	S_o	85	85	94
	VOID RATIO	e_o	.65	.61	.76
BEFORE SHEAR	WATER CONTENT, %	w_c	23.3	19.4	23.3
	DRY DENSITY LB/CU FT	γ_{d_c}	103.7	110.9	103.3
	SATURATION, %	S_c	100	100	100
	VOID RATIO	e_c	.6	.49	.6
	FINAL BACK PRESSURE, T/SQ FT	u_o	5.543	5.543	5.543
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.5	1	2
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	1.907	2.936	2.887
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	1200	1200	1200
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	1.882	2.887	2.817
INITIAL DIAMETER, IN.		D_o	1.37	1.38	1.38
INITIAL HEIGHT, IN.		H_o	3	2.99	2.99

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Clayey sand, ~~CL~~ SC B-Value 1.0 1.0 1.0

LL 27	PL 13	PI 14	G_s 2.65	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST RBAR

REMARKS: Black and gray. Torvane=0.35 TSF. Slightly organic. Specimen#3 seemed to have more soft material than the other two specimens.

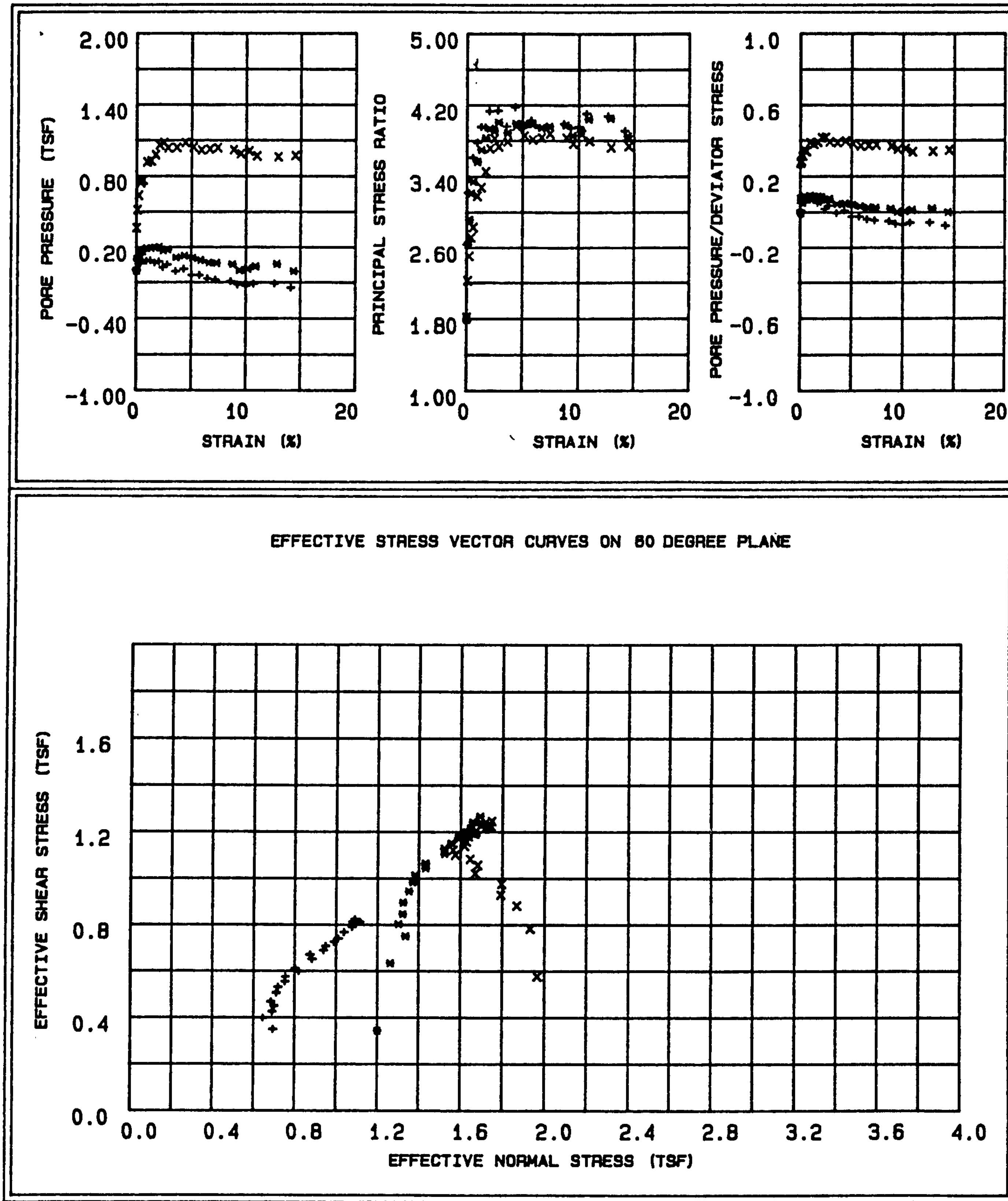
PROJECT	CHASKA; CENCS-IA-90-78-ED-GH
BORING NO 90-134 MU	SAMPLE NO. S-2
DEPTH ELEV 8'-10'	
LABORATORY 90/358	DATE 09-06-90

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)
REV JUNE 1970

FIGURE 5

FIGURE D-94



LEGEND	
+ =	.5 TSF
* =	1 TSF
X =	2 TSF

PROJECT	CHASKA: CENCS-IA-90-78-ED-GH
BORING NO.	90-134 MU
SAMPLE NO.	S-2
DEPTH/ELEV	8'-10'
MRD LAB NO.	90/358

FIGURE 6

FIGURE D-95

Table 1 - Triaxial $\bar{R}$ Test Results

Project : CHASKA; CENCS-IA-90-78-ED-GH
Boring Number : 90-134 MU
Sample Number : S-2
Depth : 8'-10'
Confining Pressure : .5 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.05	0.809	0.006	2.638	0.008	0.694	0.349
30	0.12	0.922	0.085	3.219	0.092	0.643	0.398
45	0.24	0.986	0.054	3.213	0.056	0.690	0.425
60	0.40	1.039	0.057	3.348	0.056	0.700	0.449
90	0.59	1.083	0.085	3.606	0.079	0.683	0.467
120	0.95	1.169	0.079	3.777	0.068	0.711	0.505
150	1.30	1.227	0.085	3.955	0.069	0.719	0.530
180	1.68	1.284	0.065	3.949	0.051	0.753	0.554
210	2.04	1.332	0.075	4.132	0.056	0.755	0.575
240	2.42	1.388	0.024	3.919	0.018	0.820	0.599
300	2.80	1.416	0.049	4.139	0.035	0.802	0.611
360	3.56	1.508	-0.010	3.957	-0.006	0.883	0.651
420	4.32	1.553	0.011	4.178	0.008	0.873	0.670
480	5.03	1.597	-0.043	3.942	-0.026	0.938	0.689
540	5.74	1.641	-0.043	4.023	-0.026	0.949	0.708
600	6.50	1.683	-0.072	3.944	-0.042	0.989	0.726
720	7.24	1.716	-0.083	3.942	-0.048	1.008	0.741
840	8.66	1.780	-0.096	3.986	-0.053	1.037	0.768
960	9.28	1.831	-0.123	3.937	-0.067	1.076	0.790
080	10.01	1.869	-0.133	3.950	-0.071	1.096	0.807
200	10.70	1.907	-0.115	4.102	-0.060	1.087	0.823
320	12.62	1.881	-0.112	4.074	-0.059	1.078	0.812
440	14.14	1.882	-0.148	3.906	-0.078	1.114	0.812

Table 2 - Triaxial $\bar{R}$ Test Results

Project : CHASKA; CENCS-IA-90-78-ED-GH
Boring Number : 90-134 MU
Sample Number : S-2
Depth : 8'-10'
Confining Pressure : 1 TSF

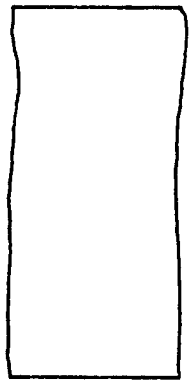
Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.05	0.794	-0.004	1.790	-0.005	1.201	0.343
30	0.12	1.468	0.101	2.632	0.069	1.262	0.634
45	0.24	1.739	0.094	2.919	0.054	1.337	0.751
60	0.41	1.861	0.159	3.212	0.086	1.302	0.803
90	0.60	1.960	0.163	3.342	0.084	1.322	0.846
120	0.97	2.075	0.190	3.562	0.092	1.324	0.896
150	1.33	2.189	0.189	3.698	0.087	1.353	0.945
180	1.72	2.281	0.194	3.831	0.086	1.371	0.984
210	2.08	2.352	0.199	3.935	0.085	1.383	1.015
240	2.46	2.421	0.167	3.908	0.070	1.432	1.045
300	2.85	2.470	0.179	4.007	0.073	1.432	1.066
360	3.63	2.565	0.111	3.884	0.044	1.524	1.107
420	4.40	2.618	0.125	3.991	0.048	1.523	1.130
480	5.13	2.671	0.105	3.985	0.040	1.556	1.153
540	5.85	2.724	0.085	3.977	0.032	1.589	1.176
600	6.63	2.753	0.064	3.941	0.024	1.618	1.188
720	7.37	2.782	0.060	3.959	0.022	1.629	1.201
840	8.82	2.823	0.050	3.970	0.018	1.649	1.218
960	9.45	2.856	-0.001	3.852	0.000	1.708	1.233
1080	10.20	2.871	0.013	3.908	0.005	1.698	1.239
1200	10.90	2.936	0.034	4.039	0.012	1.693	1.267
1320	12.86	2.879	0.055	4.048	0.020	1.658	1.243
1440	14.41	2.867	-0.007	3.847	-0.002	1.717	1.237

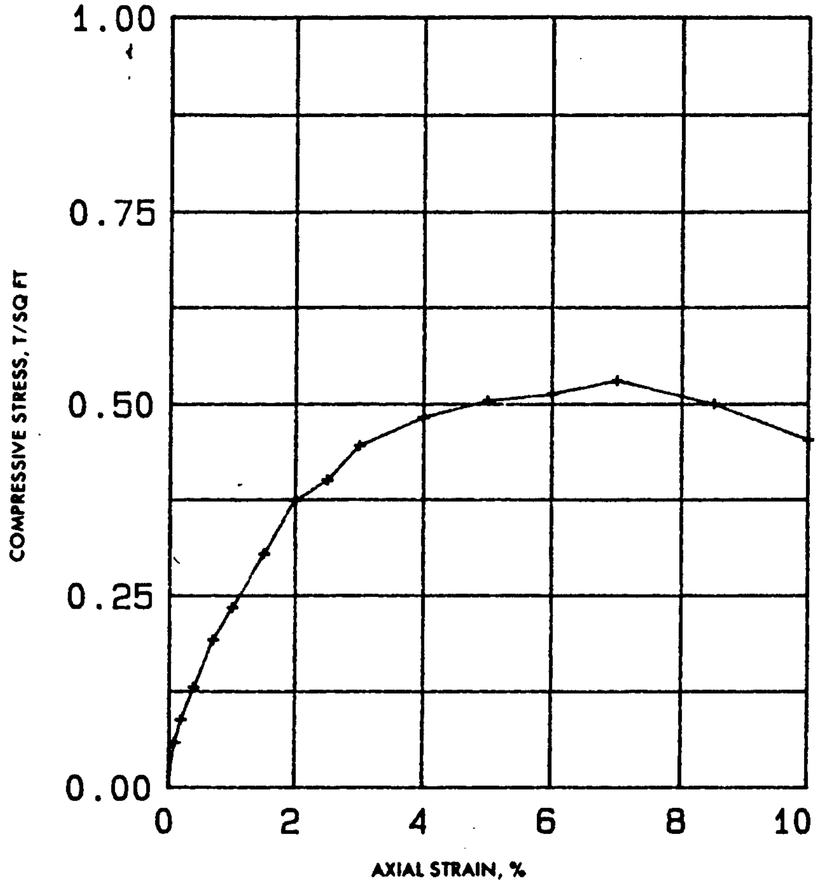
Table 3 - Triaxial $\bar{R}$ Test Results

Project : CHASKA; CENCS-IA-90-78-ED-GH
Boring Number : 90-134 MU
Sample Number : S-2
Depth : 8'-10'
Confining Pressure : 2 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.05	1.333	0.364	1.815	0.274	1.966	0.576
30	0.12	1.815	0.517	2.223	0.285	1.932	0.783
45	0.24	2.043	0.638	2.500	0.313	1.868	0.882
60	0.41	2.153	0.742	2.712	0.345	1.791	0.929
90	0.61	2.262	0.765	2.831	0.339	1.795	0.976
120	0.97	2.365	0.916	3.181	0.388	1.670	1.021
150	1.34	2.448	0.924	3.276	0.378	1.682	1.057
180	1.73	2.510	0.976	3.452	0.389	1.645	1.083
210	2.09	2.554	1.058	3.711	0.415	1.574	1.102
240	2.48	2.596	1.080	3.823	0.417	1.563	1.121
300	2.87	2.638	1.034	3.730	0.392	1.619	1.139
360	3.65	2.684	1.037	3.787	0.387	1.627	1.158
420	4.43	2.728	1.079	3.961	0.396	1.596	1.177
480	5.16	2.736	1.040	3.851	0.381	1.637	1.181
540	5.89	2.762	1.016	3.807	0.368	1.668	1.192
600	6.67	2.767	1.023	3.832	0.370	1.662	1.194
720	7.42	2.772	1.035	3.874	0.374	1.651	1.197
840	8.88	2.784	1.016	3.829	0.366	1.673	1.201
960	9.51	2.810	0.983	3.764	0.350	1.713	1.213
080	10.27	2.848	1.008	3.870	0.354	1.697	1.229
200	10.97	2.887	0.966	3.792	0.335	1.749	1.246
320	12.94	2.835	0.957	3.719	0.338	1.745	1.224
440	14.50	2.817	0.969	3.734	0.345	1.729	1.216

FAILURE SKETCHES





☐ CONTROLLED STRESS

☒ CONTROLLED STRAIN

TEST NO.						
TYPE OF SPECIMEN UNDISTURBED						
INITIAL	WATER CONTENT	w_o	59.0 %	%	%	%
INITIAL	VOID RATIO	e_o	1.59			
INITIAL	SATURATION	S_o	98 %	%	%	%
INITIAL	DRY DENSITY, LB/CU FT	γ_d	63.8			
TIME TO FAILURE, MIN		t_f	16.8			
UNCONFINED COMPRESSIVE STRENGTH, T/SQ FT		q_u	0.53			
UNDRAINED SHEAR STRENGTH, T/SQ FT		s_u	0.26			
SENSITIVITY RATIO		S_t				
INITIAL SPECIMEN DIAMETER, IN		D_o	1.38			
INITIAL SPECIMEN HEIGHT, IN.		H_o	3.00			

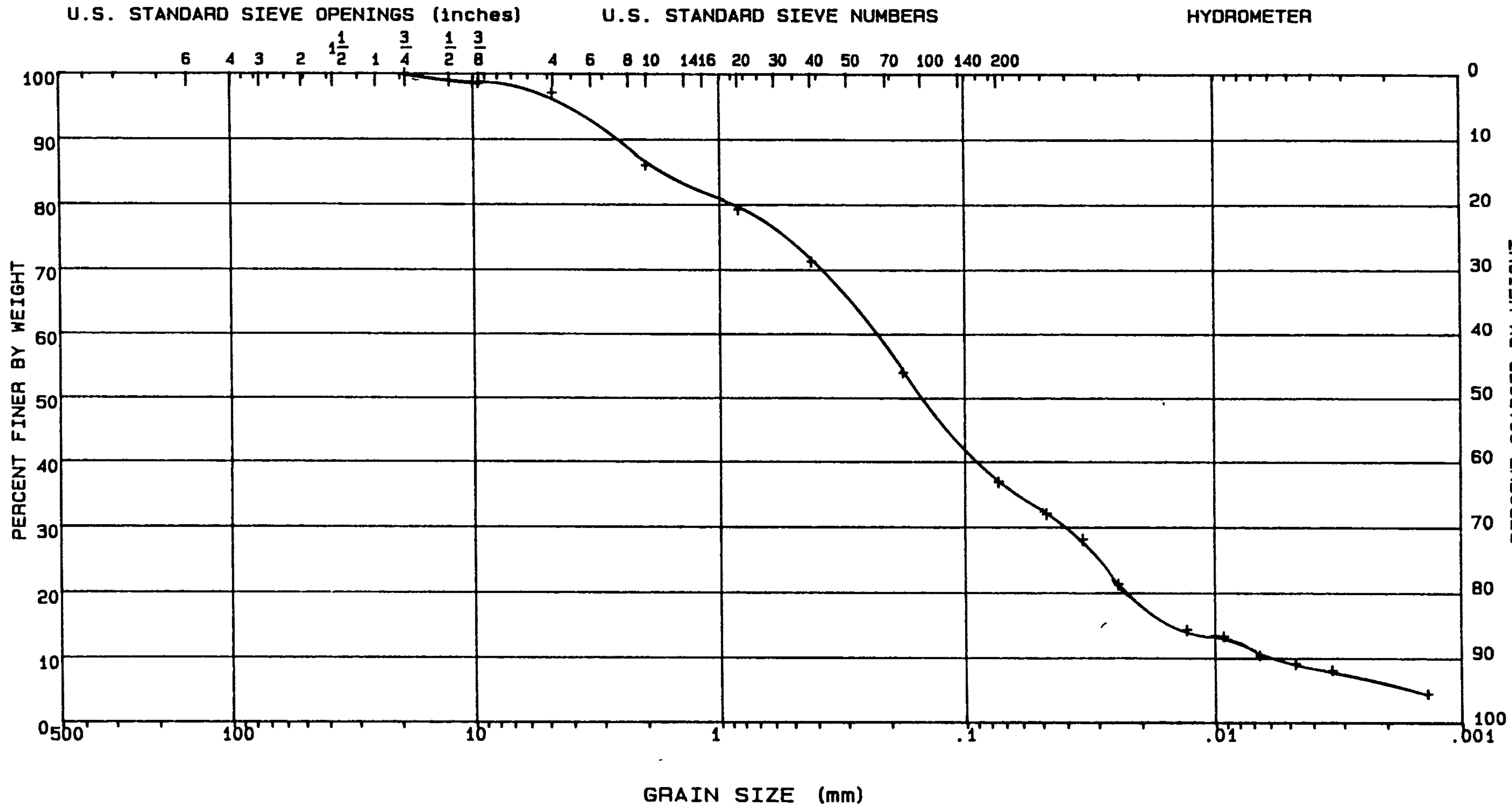
CLASSIFICATION Clayey sand SC

LL 27	PL 13	PI 14	G_s 2.65

REMARKS Black and gray. Torvane=0.35 TSF. Slightly organic.

PROJECT	CHASKA; CENCS-IA-90-78-ED-GH		
AREA	MRD LAB NO. : 90/358		
BORING NO.	90-134 MU	SAMPLE NO.	S-2
DEPTH EL	8'-10'	DATE	09-07-90

UNCONFINED COMPRESSION TEST REPORT



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

LL = 27	PL = 13	PI = 14	Gs = 2.65	NAT w = %

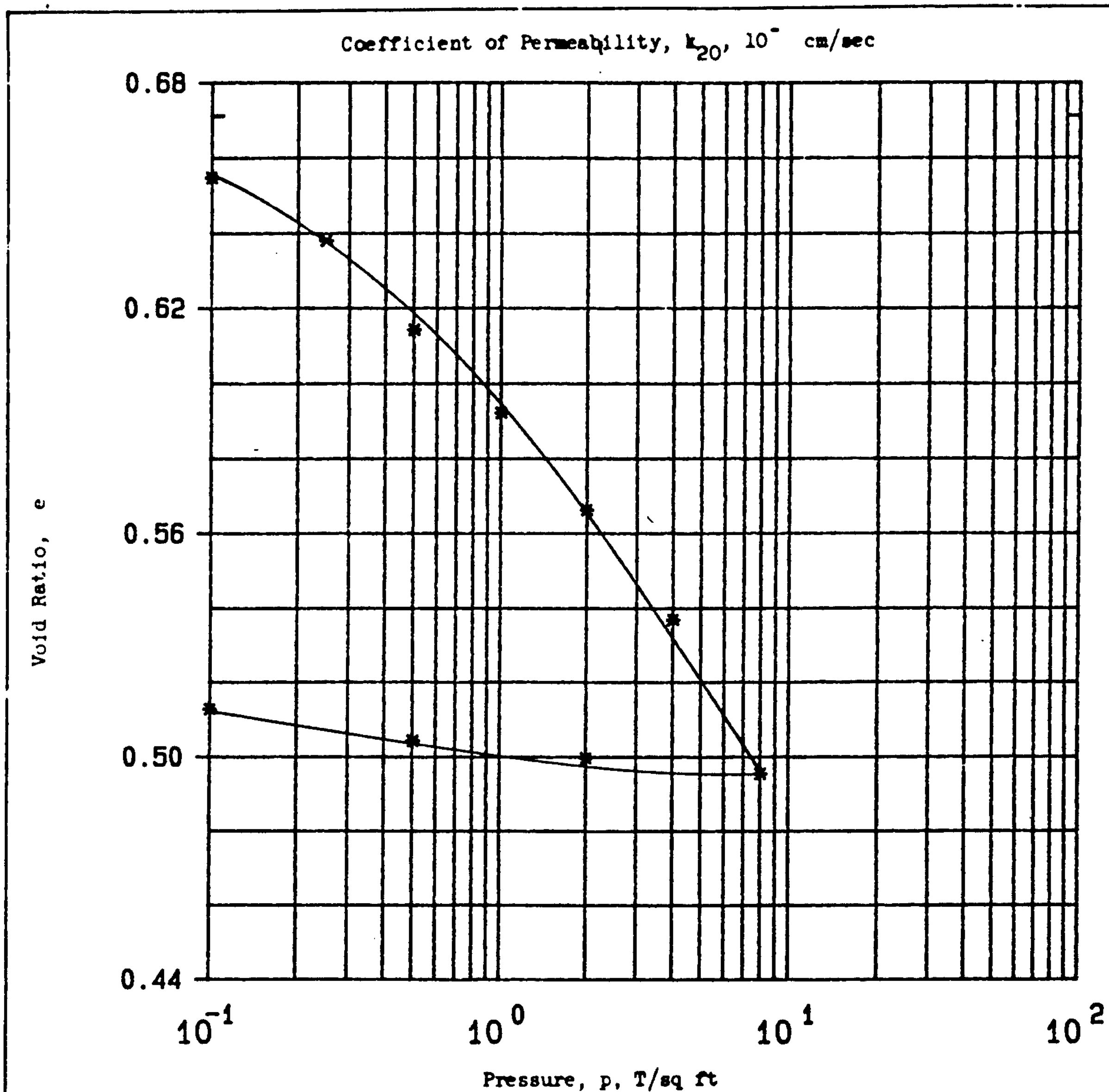
CLASSIFICATION Clayey sand, ~~CL~~ SC

GRADATION CURVE

PROJECT	CHASKA; CENCS-IA-90-78-ED-GH
DATE	09-11-90
BORING NO.	90-134 MU
SAMPLE NO.	S-2
DEPTH/ELEV	8'-10'
MRD LAB NO.	90/358

FIGURE 8

98

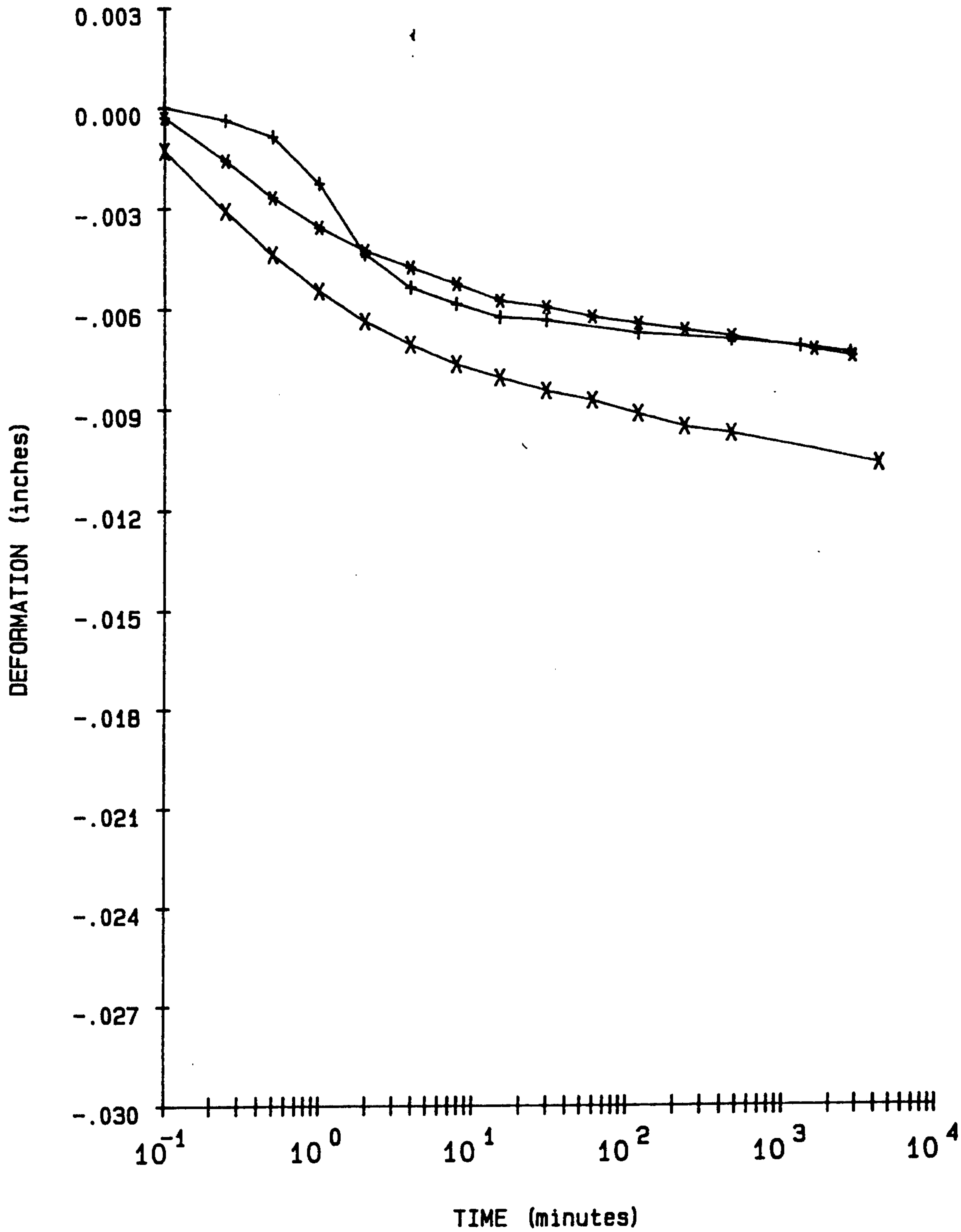


Type of Specimen UNDISTURBED		Before Test		After Test	
Diam 2.5 in.	Ht .75 in.	Water Content, w_o	23.3 %	w_f	16.8 %
Overburden Pressure, p_o T/sq ft		Void Ratio, e_o	0.67	e_f	0.51
Preconsol. Pressure, p_c T/sq ft		Saturation, S_o	93 %	S_f	88 %
Compression Index, C_c		Dry Density, γ_d	100.4 lb/ft^3		
Classification Gravelly clayey sand, SC		k_{20} at e_o = × 10^{-} cm/sec			
LL 30	G_s 2.69	Project	CHASKA; CENCS-IA-90-78-ED-GH		
PL 14	D_{10}				
Remarks Gray, gray black. Torvane= 0.25 TSF. Non-calcareous.		Area	MRD LAB NO. 90/358		
		Boring No. 90-134 MU		Sample No. S-3	
		Depth El 13'-15'		Date 09-10-90	

CONSOLIDATION TEST REPORT

ENG FORM 2090 1 MAY 63 PREVIOUS EDITIONS ARE OBSOLETE.

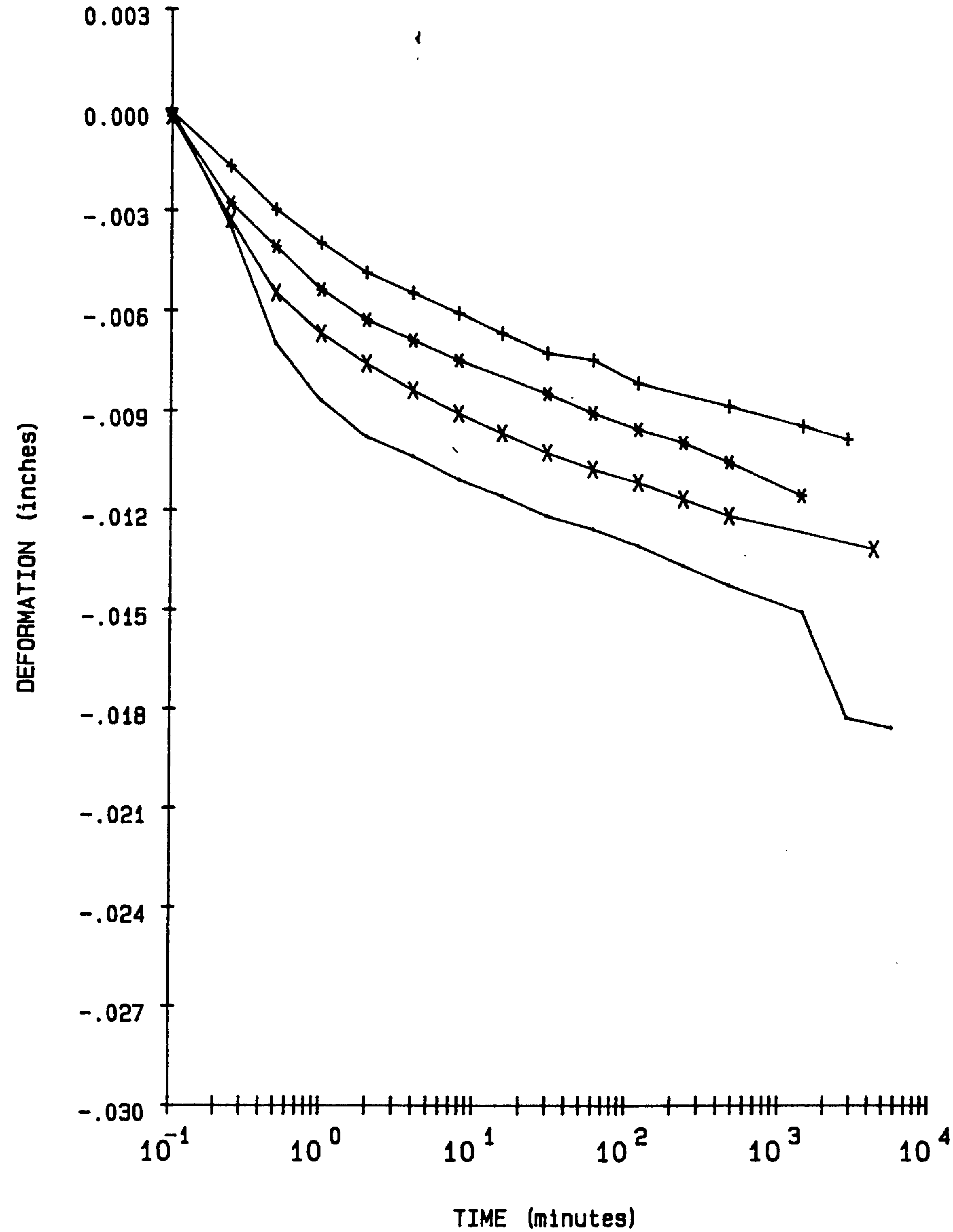
Figure 9



LEGEND	
+ = .1 TSF Wet	
✱ = .25 TSF	
X = .5 TSF	

PROJECT	CHASKA: CENCS-IA-90-78-ED-GH
BORING NO.	90-134 MU
SAMPLE NO.	S-3
DEPTH/ELEV	13'-15'
MRD LAB NO.	90/358

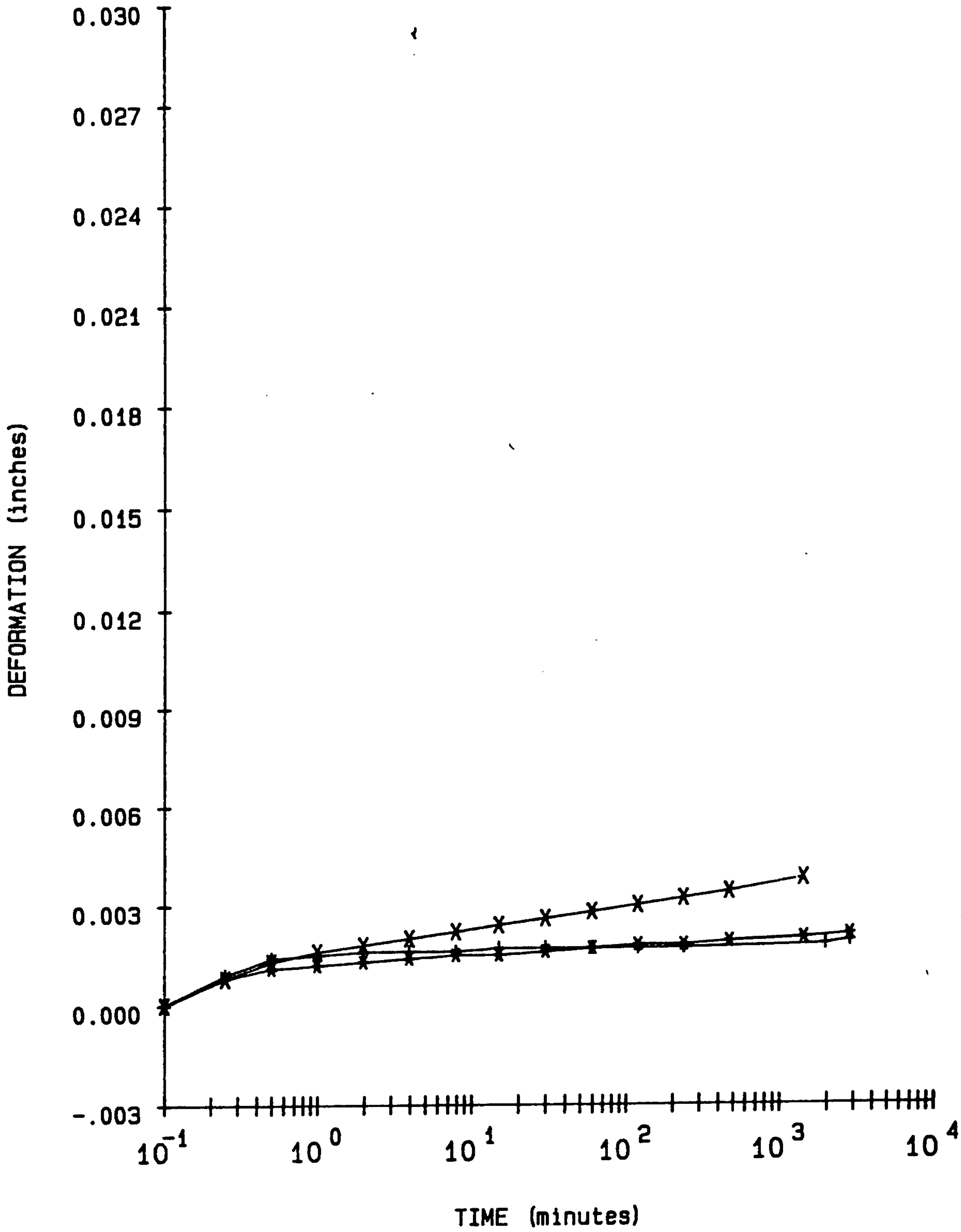
FIGURE 10



LEGEND	
+ = 1	TSF
* = 2	TSF
X = 4	TSF
- = 8	TSF

PROJECT	CHASKA: CENCS-IA-90-78-ED-GH
BORING NO.	90-134 MU
SAMPLE NO.	S-3
DEPTH/ELEV	13'-15'
MRD LAB NO.	90/358

FIGURE 11



LEGEND		
+ = 2	TSF	Rebound
✱ = .5	TSF	Rebound
X = .1	TSF	Rebound

PROJECT	CHASKA: CENCS-IA-90-78-ED-GH
BORING NO.	90-134 MU
SAMPLE NO.	S-3
DEPTH/ELEV	13'-15'
MRD LAB NO.	90/358

FIGURE 12

Consolidation Test Data

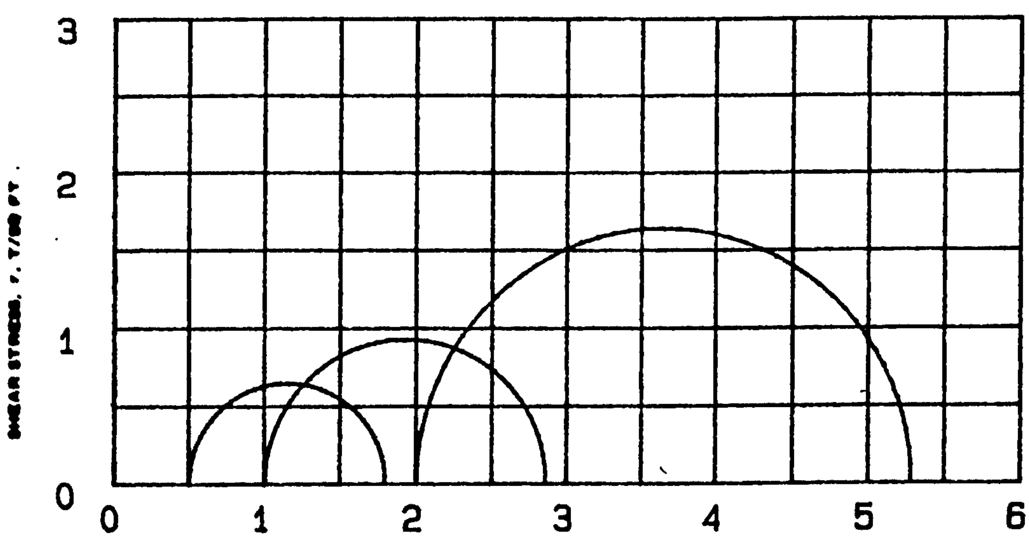
Project CHASKA; CENCS-IA-90-78-ED-GH

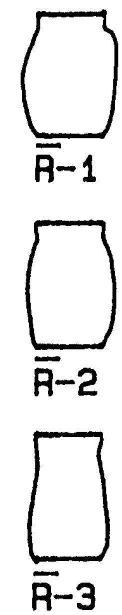
Boring No. 90-134 MU
Sample No. S-3
Depth/Elev 13'-15'
MRD Lab No. 90/358

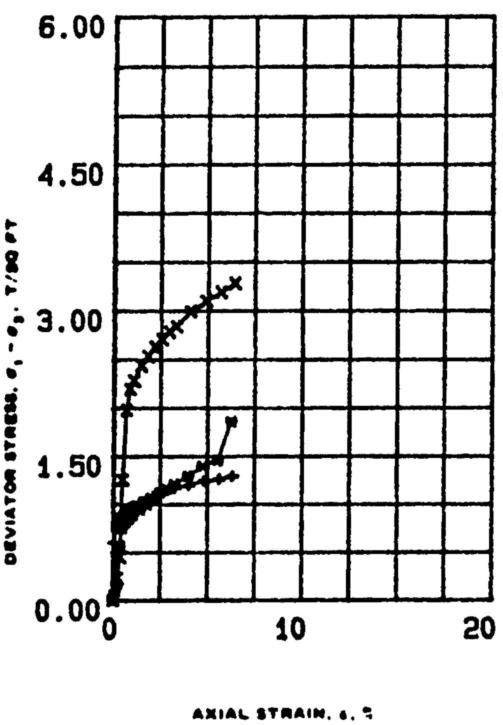
Gs = 2.69
eo = 0.671
0.42eo = 0.282

Water Content (%)	Dry Weight (gms)	Dry Density (PCF)	Void Ratio	Pressure (TSF)	Saturation (%)
23.3	96.7	100.4	0.671		93.4
16.8	96.7	101.4	0.655	0.10	68.9
16.8	96.7	102.5	0.638	0.25	70.7
16.8	96.7	104.0	0.614	0.50	73.4
16.8	96.7	105.4	0.592	1.00	76.2
16.8	96.7	107.2	0.566	2.00	79.6
16.8	96.7	109.2	0.537	4.00	84.0
16.8	96.7	112.3	0.495	8.00	91.0
16.8	96.7	111.9	0.500	2.00	90.2
16.8	96.7	111.6	0.504	0.50	89.4
16.8	96.7	111.0	0.513	0.10	87.9

Axial Strain (%)	Void Ratio
1	0.654
2	0.638
3	0.621
4	0.604
5	0.588
6	0.571
7	0.554
8	0.537
9	0.521
10	0.504
11	0.487
12	0.471
13	0.454







			1 (+)	2 (#)	3 (X)
SPECIMEN NO.			1 (+)	2 (#)	3 (X)
INITIAL	WATER CONTENT, %	w_o	24.4	25.8	23.6
	DRY DENSITY LB/CU FT	γd_o	93.7	98.6	104.2
	SATURATION, %	S_o	83	99	100
	VOID RATIO	e_o	.79	.7	.61
BEFORE SHEAR	WATER CONTENT, %	w_c	23	23.8	22.3
	DRY DENSITY LB/CU FT	γd_c	104.1	103.2	108.9
	SATURATION, %	S_c	100	100	100
	VOID RATIO	e_c	.61	.63	.59
	FINAL BACK PRESSURE, T/SQ FT	u_o	4.103	4.103	4.103
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.5	1	2
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	1.295	1.857	3.279
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	720	720	720
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	1.295	1.857	3.279
INITIAL DIAMETER, IN.		D_o	1.41	1.34	1.35
INITIAL HEIGHT, IN.		H_o	3.01	2.99	2.89

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Gravelly clayey sand, SC B-Value 1.0 1.0 1.0

LL 30 | PL 14 | PI 16 | G_s 2.69

TYPE OF SPECIMEN UNDISTURBED | TYPE OF TEST RBAR

REMARKS: Gray, gray black. Torvane= 0.25 TSF. Non-calcareous. The test was stopped due to a malfunction of the data ecquisition system.

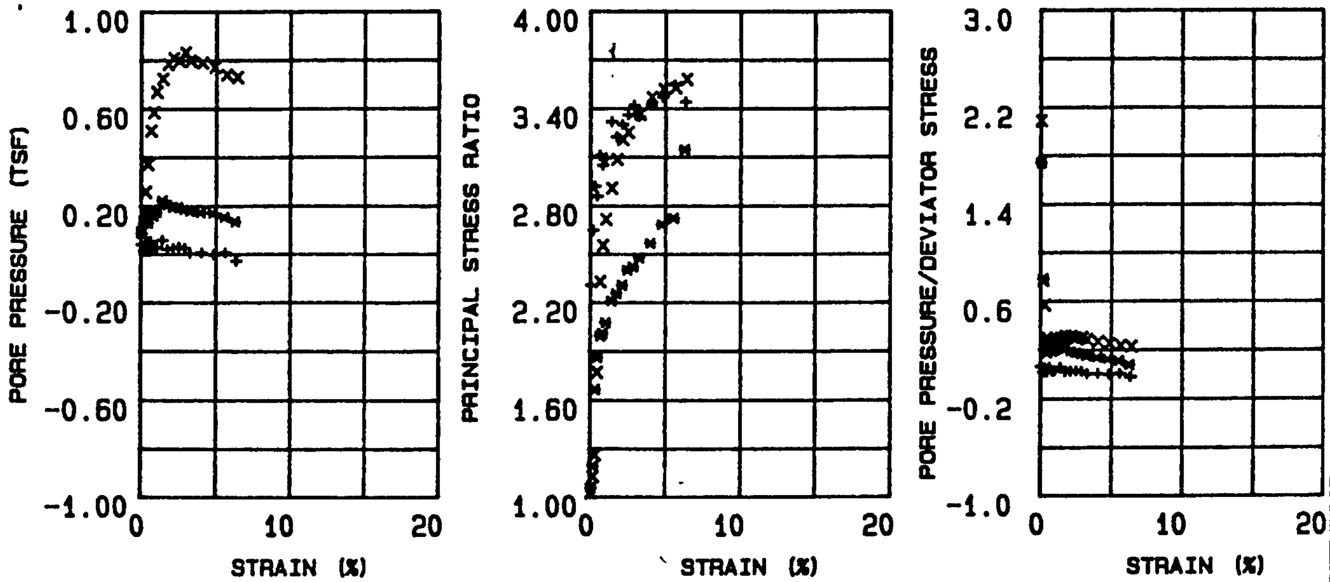
PROJECT CHASKA: CENCS-IA-90-78-ED-GH

BORING NO. 90-134 MU | SAMPLE NO. S-3

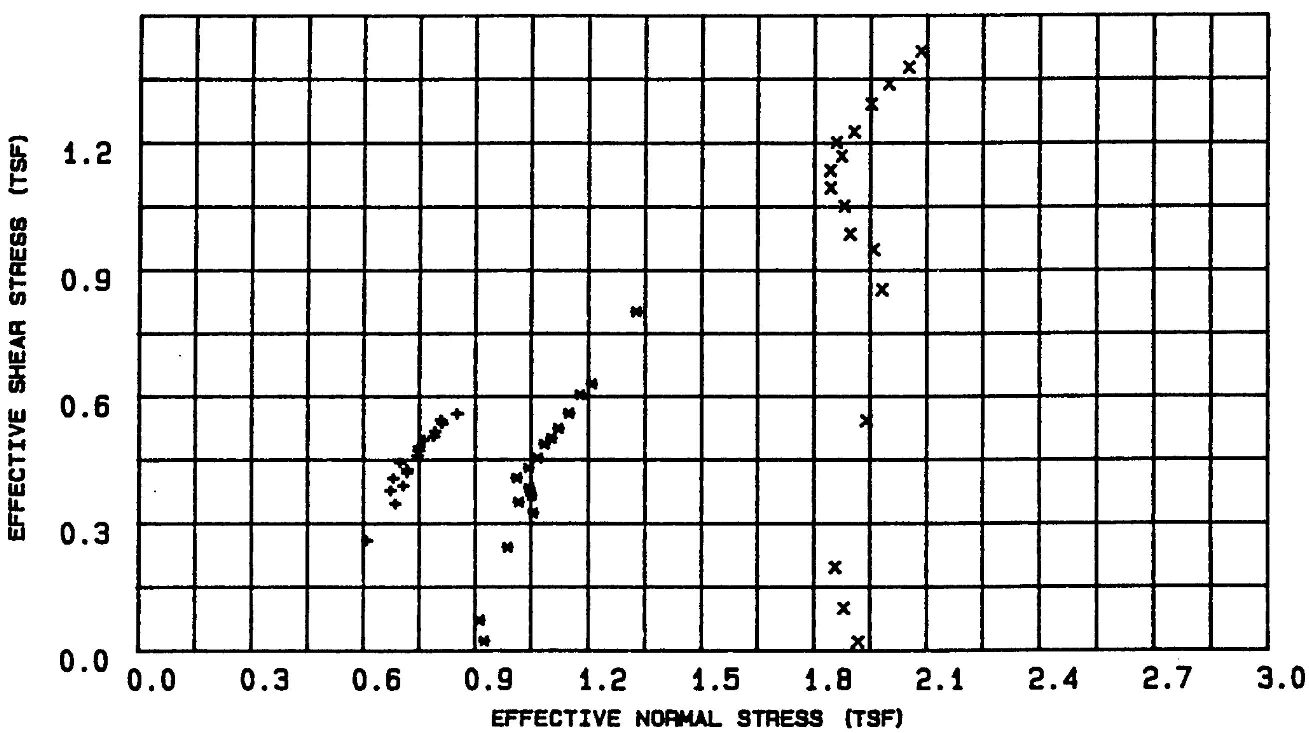
DEPTH ELEV 13'-15'

LABORATORY 90/358 | DATE 09-10-90

TRIAXIAL COMPRESSION TEST REPORT



EFFECTIVE STRESS VECTOR CURVES ON 60 DEGREE PLANE



LEGEND

+ = .5 TSF
ж = 1 TSF
X = 2 TSF

PROJECT	CHASKA: CENCS-IA-90-78-ED-GH
BORING NO.	90-134 MU
SAMPLE NO.	S-3
DEPTH/ELEV	13'-15'
MRD LAB NO.	90/358

FIGURE 14

Table 4 - Triaxial $\overline{R}$ Test Results

Project : CHASKA; CENCS-IA-90-78-ED-GH
Boring Number : 90-134 MU
Sample Number : S-3
Depth : 13'-15'
Confining Pressure : .5 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.07	0.601	0.040	2.305	0.066	0.609	0.259
30	0.22	0.802	0.013	2.647	0.017	0.685	0.346
45	0.34	0.873	0.045	2.918	0.052	0.671	0.377
60	0.49	0.898	0.016	2.857	0.019	0.706	0.388
90	0.68	0.941	0.054	3.109	0.058	0.679	0.406
120	0.86	0.974	0.024	3.048	0.026	0.717	0.420
150	1.05	0.989	0.027	3.093	0.028	0.718	0.427
180	1.44	1.027	0.057	3.318	0.056	0.697	0.443
210	1.78	1.066	0.020	3.222	0.020	0.744	0.460
240	2.15	1.095	0.024	3.301	0.023	0.747	0.472
300	2.52	1.114	0.028	3.362	0.026	0.748	0.481
360	2.91	1.151	0.024	3.420	0.022	0.761	0.497
420	3.28	1.170	0.002	3.349	0.002	0.788	0.505
480	4.04	1.198	0.005	3.421	0.005	0.792	0.517
540	4.82	1.243	-0.003	3.470	-0.002	0.811	0.536
600	5.60	1.260	0.005	3.546	0.005	0.807	0.544
720	6.33	1.295	-0.030	3.441	-0.023	0.851	0.559

Table 5 - Triaxial $\bar{R}$ Test Results

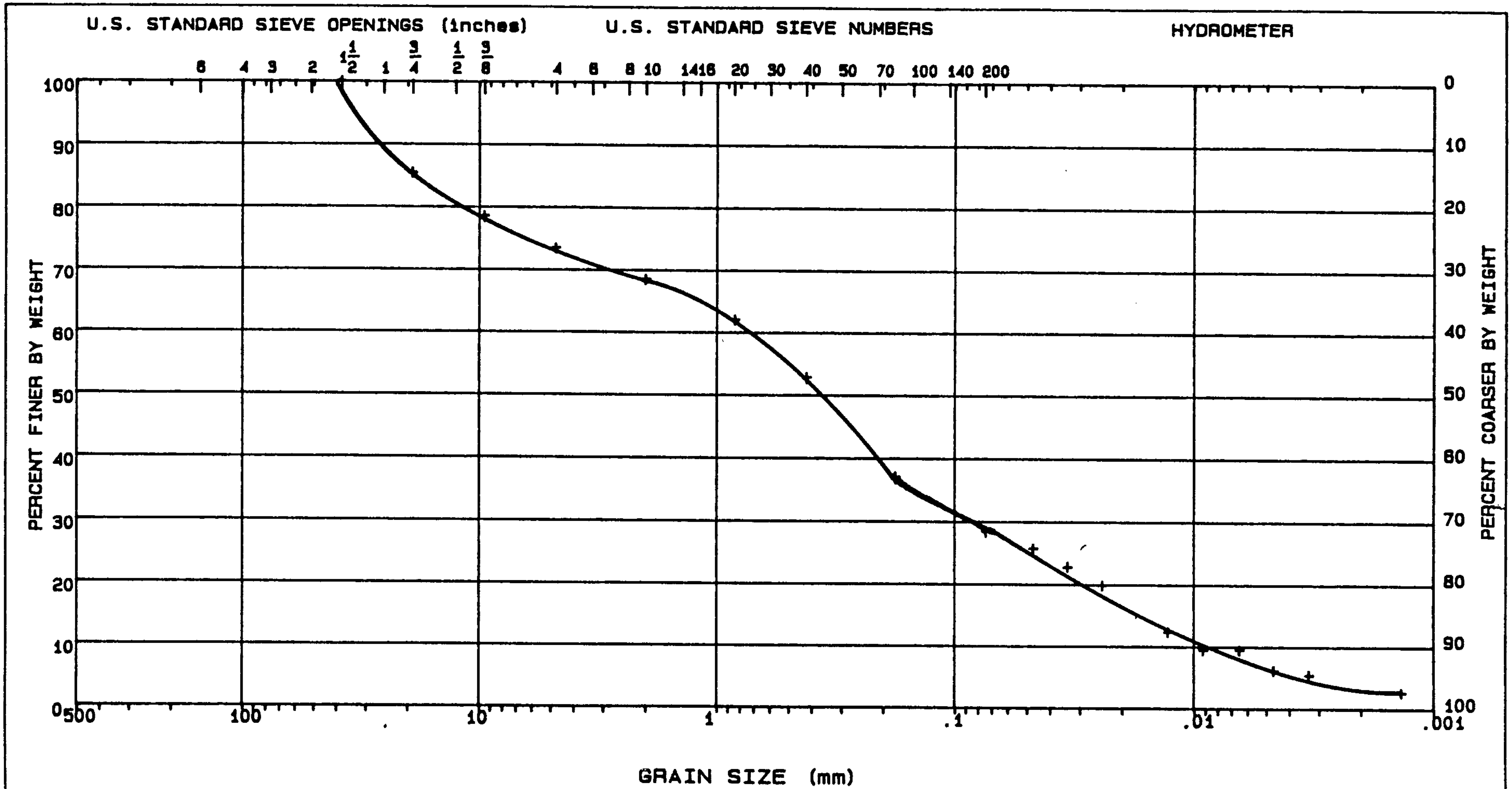
Project : CHASKA; CENCS-IA-90-78-ED-GH
Boring Number : 90-134 MU
Sample Number : S-3
Depth : 13'-15'
Confining Pressure : 1 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.07	0.051	0.088	1.056	1.739	0.925	0.022
30	0.22	0.165	0.129	1.190	0.780	0.912	0.071
45	0.34	0.564	0.152	1.665	0.270	0.988	0.243
60	0.48	0.751	0.130	1.863	0.174	1.056	0.324
90	0.68	0.810	0.184	1.993	0.228	1.017	0.350
120	0.85	0.849	0.159	2.010	0.188	1.051	0.366
150	1.04	0.887	0.175	2.076	0.198	1.045	0.383
180	1.43	0.942	0.221	2.209	0.235	1.012	0.407
210	1.76	0.998	0.204	2.254	0.205	1.043	0.431
240	2.13	1.052	0.194	2.306	0.185	1.067	0.454
300	2.49	1.127	0.194	2.399	0.173	1.085	0.487
360	2.87	1.160	0.184	2.421	0.159	1.103	0.501
420	3.24	1.213	0.178	2.476	0.147	1.122	0.524
480	3.99	1.297	0.172	2.568	0.133	1.149	0.560
[illegible]40	4.76	1.400	0.169	2.685	0.122	1.178	0.604
[illegible]00	5.53	1.460	0.153	2.724	0.106	1.208	0.630
720	6.25	1.857	0.134	3.145	0.073	1.326	0.802

Table 6 - Triaxial $\bar{R}$ Test Results

Project : CHASKA; CENCS-IA-90-78-ED-GH
Boring Number : 90-134 MU
Sample Number : S-3
Depth : 13'-15'
Confining Pressure : 2 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.07	0.044	0.092	1.023	2.088	1.919	0.019
30	0.22	0.230	0.177	1.126	0.768	1.880	0.099
45	0.35	0.453	0.256	1.260	0.566	1.856	0.196
60	0.49	1.255	0.371	1.770	0.296	1.940	0.542
90	0.69	1.978	0.509	2.326	0.258	1.981	0.854
120	0.87	2.196	0.585	2.552	0.267	1.959	0.948
150	1.07	2.282	0.669	2.715	0.294	1.896	0.985
180	1.46	2.435	0.723	2.907	0.297	1.880	1.051
210	1.81	2.534	0.784	3.084	0.310	1.843	1.094
240	2.18	2.630	0.809	3.208	0.308	1.842	1.135
300	2.55	2.708	0.797	3.251	0.295	1.873	1.169
360	2.95	2.784	0.831	3.382	0.299	1.858	1.201
420	3.32	2.841	0.797	3.362	0.281	1.906	1.226
480	4.09	2.990	0.789	3.470	0.264	1.951	1.291
540	4.88	3.100	0.770	3.520	0.249	1.998	1.338
600	5.68	3.189	0.739	3.529	0.232	2.051	1.377
720	6.42	3.279	0.729	3.580	0.223	2.083	1.415



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

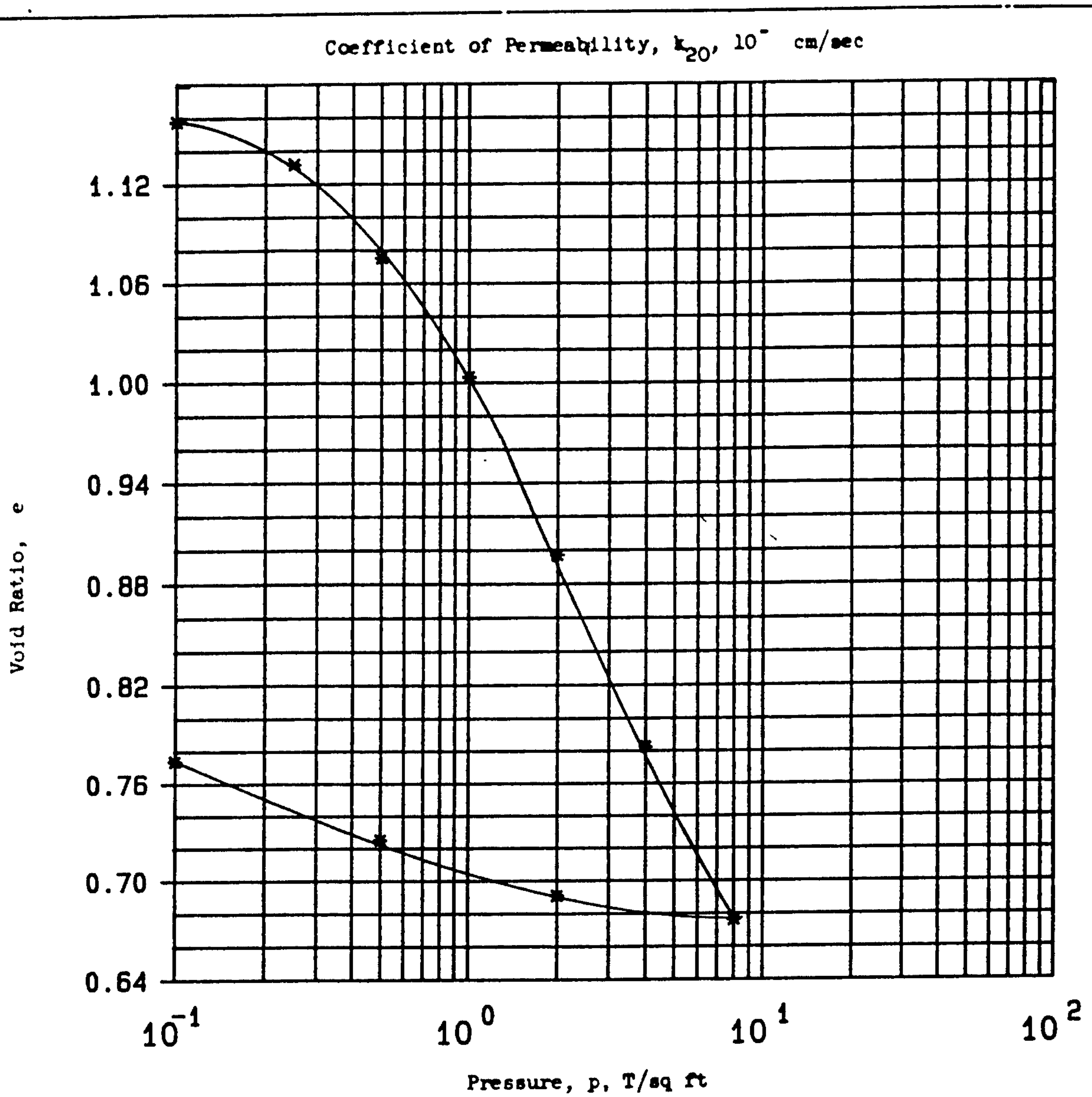
LL = 30	PL = 14	PI = 16	Gs = 2.69	NAT w = %

CLASSIFICATION Gravelly clayey sand, SC

PROJECT	CHASKA; CENCS-IA-90-78-ED-GH
DATE	09-11-90
BORING NO.	90-134 MU
SAMPLE NO.	S-3
DEPTH/ELEV	13'-15'
MRD LAB NO.	90/358

GRADATION CURVE

FIGURE 15

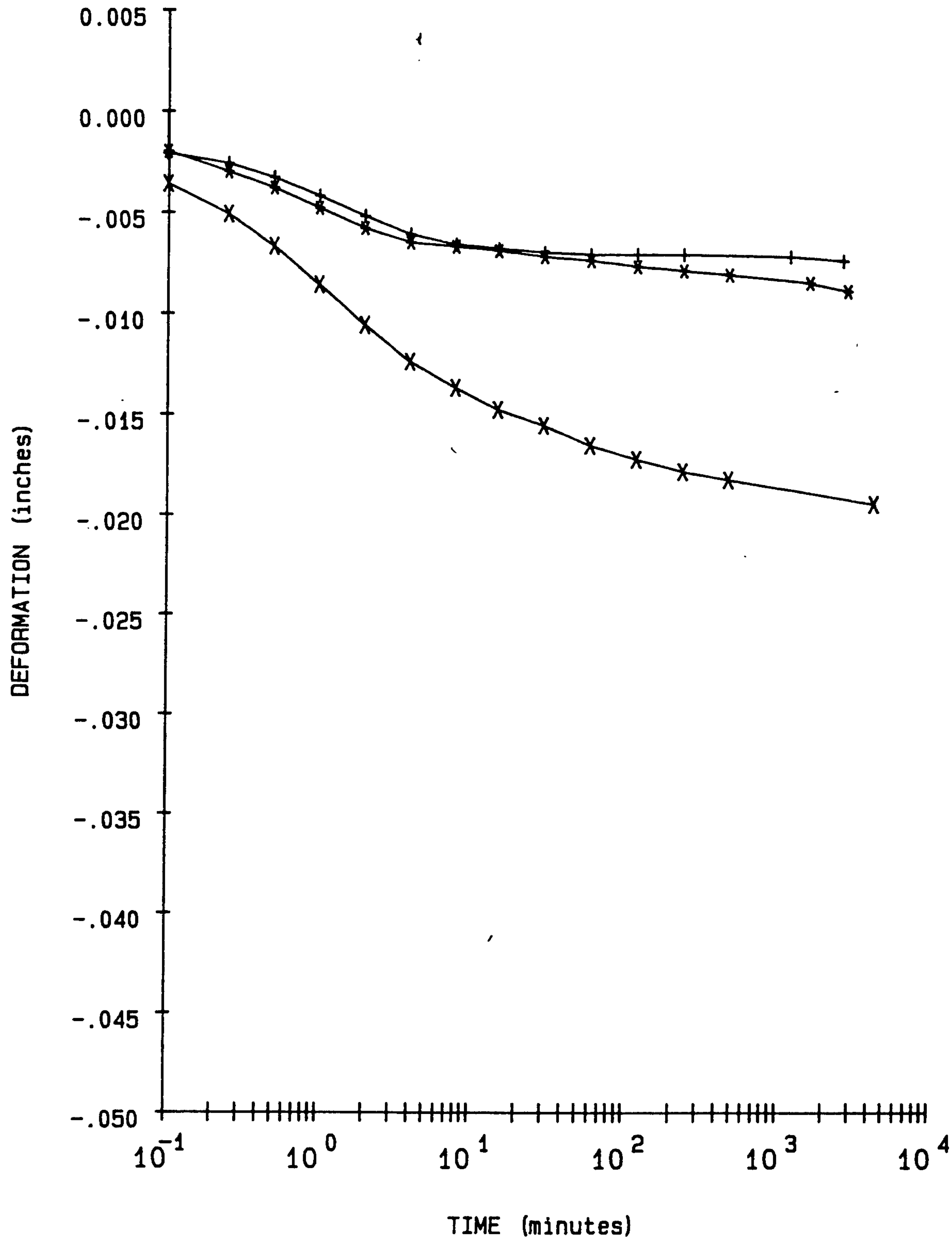


Type of Specimen UNDISTURBED		Before Test		After Test	
Diam 2.5 in.	Ht .75 in.	Water Content, w_o	35.6 %	w_f	35.0 %
Overburden Pressure, Po T/sq ft		Void Ratio, e_o	1.18	e_f	0.77
Preconsol. Pressure, Pc T/sq ft		Saturation, S_o	80 %	S_f	100 %
Compression Index, C_c		Dry Density, γ_d	75.9 lb/ft^3		
Classification Silty sand, SM		k_{20} at e_o = x 10^{-} cm/sec			

LL 20	G_s 2.65	Project	CHASKA: CENCS-IA-90-78-ED-GH
PL 16	D_{10}		
Remarks Gray Brown. Too soft for Torvane. Non-calcareous.		Area	MRD LAB NO. 90/358
		Boring No. 90-139 MU	Sample No. S-1
		Depth El 14'-16'	Date 09-10-90
		CONSOLIDATION TEST REPORT	

ENG FORM 1 MAY 63 2090 PREVIOUS EDITIONS ARE OBSOLETE.

Figure 16



LEGEND

+ = .1 TSF Wet

* = .25 TSF

X = .5 TSF

PROJECT	CHASKA: CENCS-IA-90-78-ED-GH
BORING NO.	90-139 MU
SAMPLE NO.	S-1
DEPTH/ELEV	14'-16'
MRD LAB NO.	90/358

FIGURE 17

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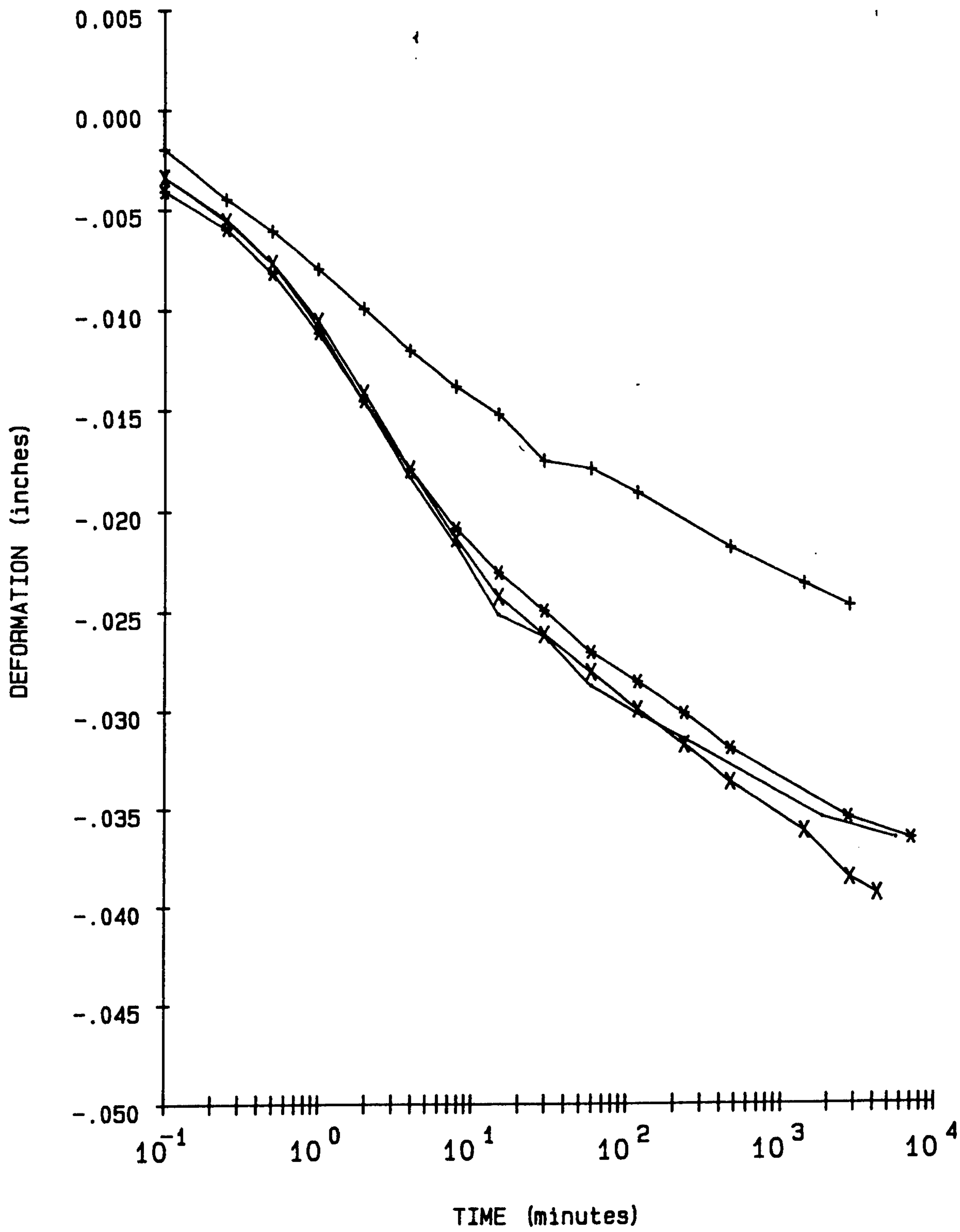
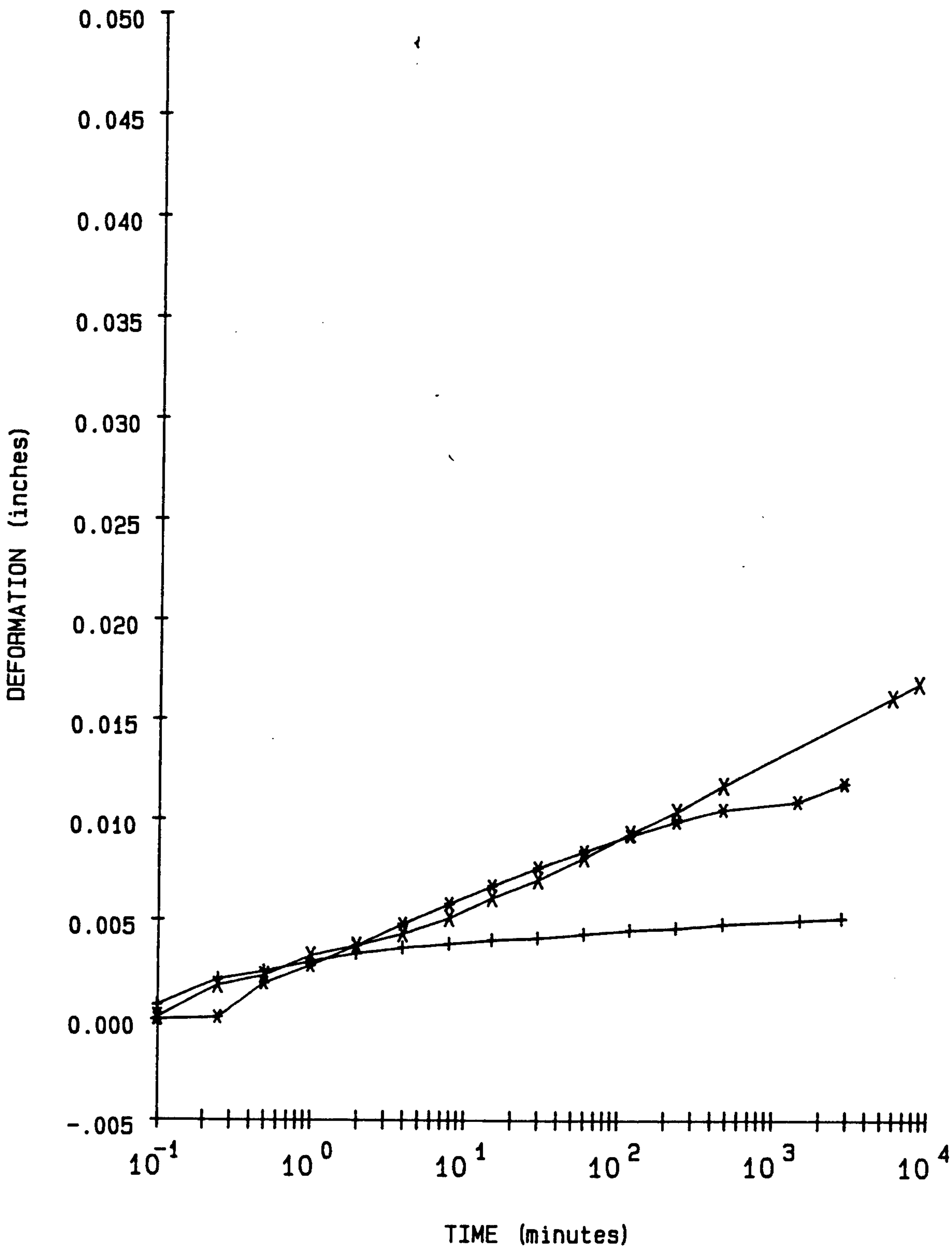


LEGEND	
+ = 1	TSF
* = 2	TSF
X = 4	TSF
- = 8	TSF

PROJECT	CHASKA: CENCS-IA-90-78-ED-GH
BORING NO.	90-139 MU
SAMPLE NO.	S-1
DEPTH/ELEV	14'-16'
MRD LAB NO.	90/358

FIGURE 18



LEGEND

+ = 2 TSF Rebound
* = .5 TSF Rebound
X = .1 TSF Rebound

PROJECT	CHASKA: CENCS-IA-90-78-ED-GH
BORING NO.	90-139 MU
SAMPLE NO.	S-1
DEPTH/ELEV	14'-16'
MRD LAB NO.	90/358

FIGURE 19

Consolidation Test Data

Project CHASKA; CENCS-IA-90-78-ED-GH

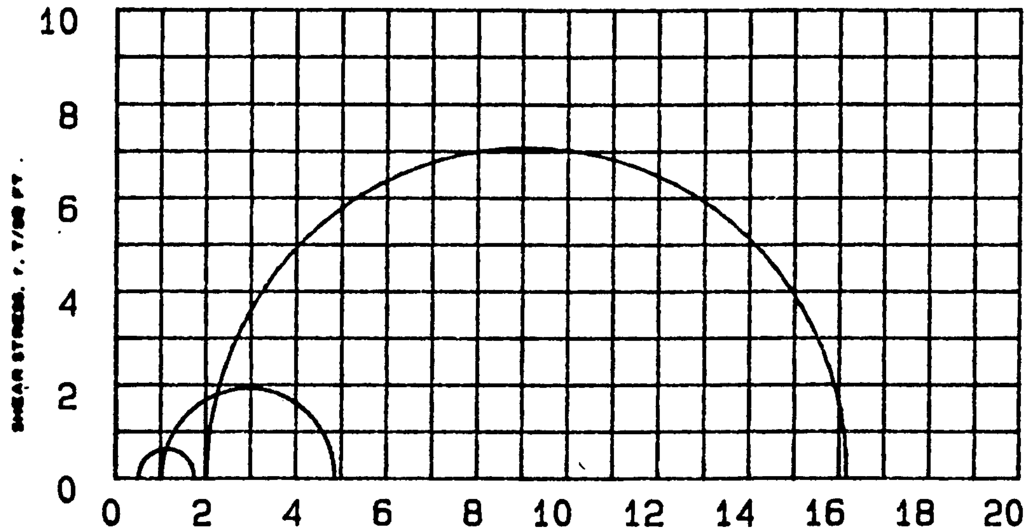
Boring No. 90-139 MU
Sample No. S-1
Depth/Elev 14'-16'
MRD Lab No. 90/358

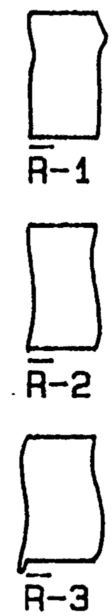
Gs = 2.65
eo = 1.179
0.42eo = 0.495

Water Content (%)	Dry Weight (gms)	Dry Density (PCF)	Void Ratio	Pressure (TSF)	Saturation (%)
35.6	73.0	75.9	1.179		80.1
35.0	73.0	76.6	1.158	0.10	80.1
35.0	73.0	77.6	1.132	0.25	81.9
35.0	73.0	79.7	1.075	0.50	86.2
35.0	73.0	82.6	1.003	1.00	92.4
35.0	73.0	87.2	0.897	2.00	100.0
35.0	73.0	92.8	0.782	4.00	100.0
35.0	73.0	98.7	0.676	8.00	100.0
35.0	73.0	97.8	0.691	2.00	100.0
35.0	73.0	95.9	0.725	0.50	100.0
35.0	73.0	93.2	0.774	0.10	100.0

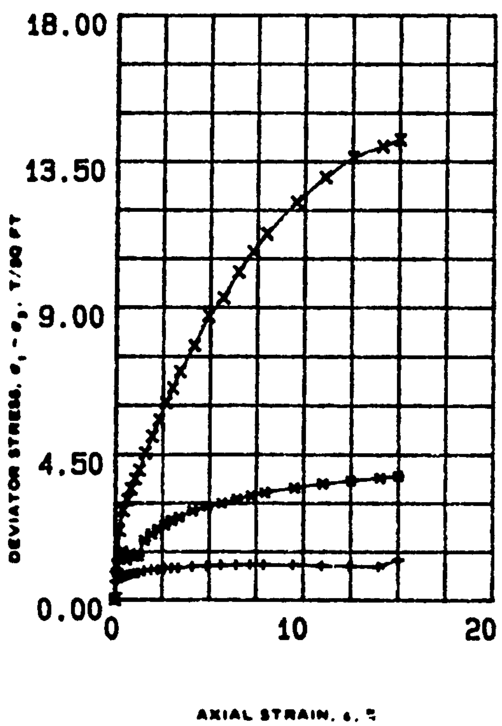
Axial Strain (%)	Void Ratio
1	1.157
2	1.135
3	1.114
4	1.092
5	1.070
6	1.048
7	1.026
8	1.005
9	0.983
10	0.961
11	0.939
12	0.918
13	0.896
14	0.874
15	0.852
16	0.830
17	0.809
18	0.787
19	0.765
20	0.743

FIGURE D-116





NORMAL STRESS, σ, T/SQ FT



SPECIMEN NO.			1 (+)	2 (✱)	3 (X)	
INITIAL	WATER CONTENT, %	w_o	42.9	26.3	21.6	
	DRY DENSITY LB/CU FT	γ_{d_o}	71.7	93.2	104.1	
	SATURATION, %	S_o	87	90	97	
	VOID RATIO	e_o	1.31	.78	.59	
BEFORE SHEAR	WATER CONTENT, %	w_c	50	28.1	23.8	
	DRY DENSITY LB/CU FT	γ_{d_c}	74.6	98.5	104.2	
	SATURATION, %	S_c	100	100	100	
	VOID RATIO	e_c	1.22	.68	.59	
	FINAL BACK PRESSURE, T/SQ FT	u_o	3.383	3.383	3.383	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.5	1	2	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	1.241	3.847	14.169	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	1522	1516	1511	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	1.241	3.847	14.169	
INITIAL DIAMETER, IN.		D_o	1.38	1.38	1.38	
INITIAL HEIGHT, IN.		H_o	2.99	2.99	2.92	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Silty sand, SM B-Value 1.0 1.0 1.0

LL 20	PL 16	PI 4	Gs 2.65	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST RBAR

REMARKS: Gray brown. Too soft for torvane. Non-calcareous.

PROJECT CHASKA; CENCS-IA-90-78-ED-GH

BORING NO. 90-139 MU | SAMPLE NO. S-1

DEPTH ELEV 14'-16'

LABORATORY 90/358 | DATE 09-12-90

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

FIGURE 20

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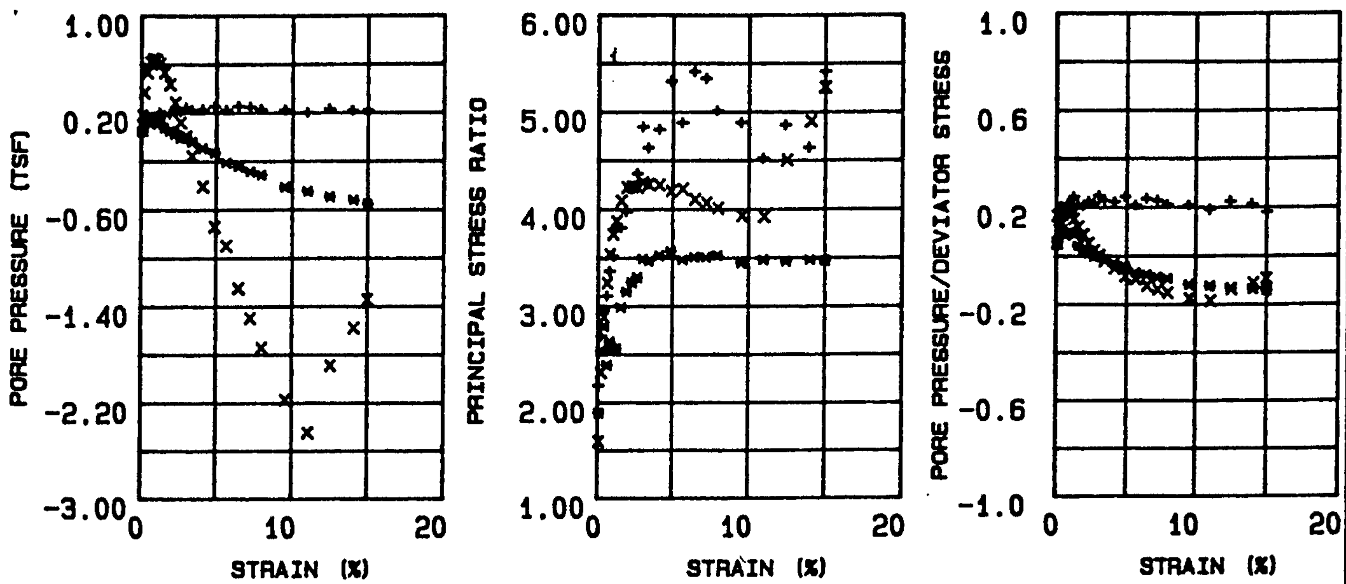
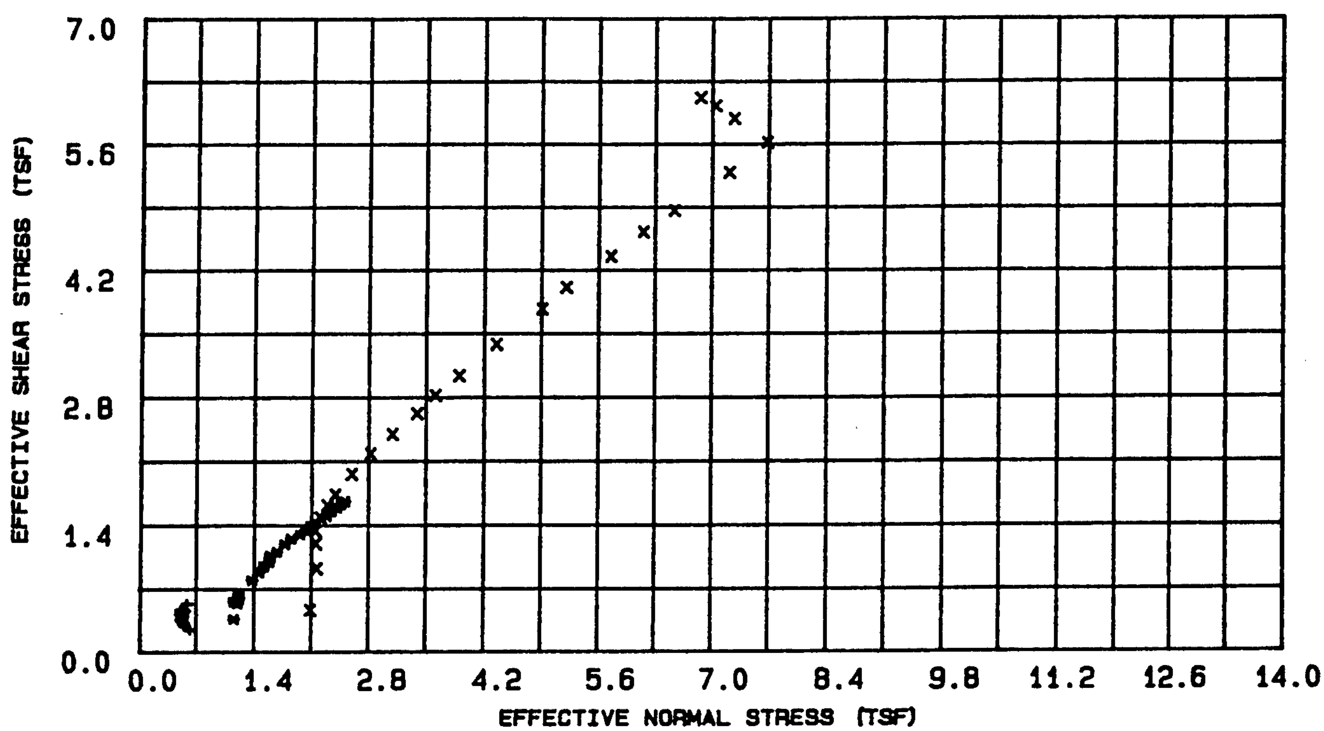


EFFECTIVE STRESS VECTOR CURVES ON 60 DEGREE PLANE



LEGEND

+ = .5 TSF

⌘ = 1 TSF

X = 2 TSF

PROJECT	CHASKA: CENCS-IA-90-78-ED-GH
BORING NO.	90-139 MU
SAMPLE NO.	S-1
DEPTH/ELEV	14'-16'
MRD LAB NO.	90/358

FIGURE 21

FIGURE D-118

R

Table 7 - Triaxial $\overline{R}$ Test Results

Project	: CHASKA; CENCS-IA-90-78-ED-GH
Boring Number	: 90-139 MU
Sample Number	: S-1
Depth	: 14'-16'
Confining Pressure	: .5 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.09	0.566	0.018	2.175	0.033	0.622	0.244
30	0.24	0.667	0.106	2.691	0.159	0.559	0.288
45	0.43	0.719	0.134	2.964	0.186	0.544	0.310
60	0.64	0.753	0.142	3.105	0.189	0.544	0.325
90	0.81	0.787	0.167	3.362	0.212	0.528	0.340
120	1.03	0.820	0.174	3.519	0.213	0.529	0.354
150	1.24	0.835	0.202	3.803	0.243	0.505	0.360
180	1.55	0.885	0.185	3.808	0.210	0.534	0.382
210	1.91	0.924	0.189	3.973	0.205	0.540	0.399
240	2.27	0.935	0.210	4.221	0.225	0.522	0.404
300	2.63	0.974	0.211	4.366	0.217	0.530	0.420
360	2.99	0.985	0.244	4.846	0.248	0.500	0.425
420	3.37	0.996	0.226	4.629	0.227	0.521	0.430
[illegible]80	4.09	1.035	0.229	4.818	0.222	0.527	0.447
540	4.86	1.055	0.256	5.318	0.243	0.505	0.455
600	5.62	1.075	0.224	4.887	0.208	0.542	0.464
720	6.41	1.084	0.255	5.417	0.235	0.513	0.468
840	7.18	1.094	0.248	5.344	0.227	0.523	0.472
960	7.91	1.087	0.229	5.009	0.211	0.540	0.469
1080	9.47	1.079	0.222	4.887	0.207	0.545	0.466
1200	10.95	1.055	0.200	4.517	0.190	0.561	0.455
1320	12.41	1.040	0.231	4.866	0.223	0.526	0.449
1440	13.96	1.030	0.216	4.628	0.210	0.539	0.445
1522	15.00	1.241	0.219	5.418	0.179	0.588	0.535

Table 8 - Triaxial $\bar{R}$ Test Results

Project : CHASKA; CENCS-IA-90-78-ED-GH
Boring Number : 90-139 MU
Sample Number : S-1
Depth : 14'-16'
Confining Pressure : 1 TSF

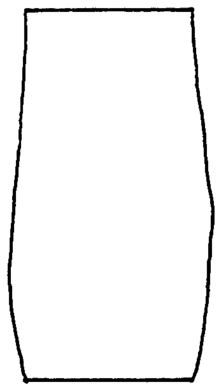
Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.10	0.844	0.049	1.888	0.058	1.160	0.364
30	0.24	1.288	0.162	2.536	0.126	1.157	0.556
45	0.43	1.506	0.159	2.790	0.106	1.214	0.650
60	0.65	1.238	0.106	2.385	0.086	1.201	0.534
90	0.82	1.416	0.132	2.630	0.093	1.219	0.611
120	1.03	1.350	0.130	2.552	0.097	1.204	0.583
150	1.25	1.366	0.123	2.557	0.091	1.215	0.589
180	1.56	1.838	0.076	2.989	0.042	1.379	0.793
210	1.92	2.048	0.047	3.149	0.024	1.460	0.884
240	2.28	2.195	0.022	3.245	0.010	1.522	0.948
300	2.65	2.322	-0.010	3.299	-0.004	1.585	1.002
360	3.01	2.468	0.008	3.489	0.004	1.603	1.065
420	3.39	2.573	-0.044	3.464	-0.017	1.681	1.110
480	4.11	2.761	-0.094	3.523	-0.034	1.777	1.192
540	4.88	2.905	-0.133	3.564	-0.045	1.852	1.254
600	5.65	3.009	-0.214	3.478	-0.071	1.959	1.299
720	6.44	3.128	-0.248	3.506	-0.079	2.022	1.350
840	7.21	3.226	-0.288	3.504	-0.089	2.087	1.393
960	7.96	3.324	-0.317	3.524	-0.095	2.140	1.435
080	9.52	3.473	-0.420	3.446	-0.120	2.280	1.499
200	11.01	3.600	-0.454	3.477	-0.126	2.345	1.554
320	12.48	3.686	-0.499	3.459	-0.135	2.412	1.591
440	14.04	3.780	-0.526	3.477	-0.139	2.462	1.631
515	15.00	3.847	-0.558	3.469	-0.145	2.511	1.661

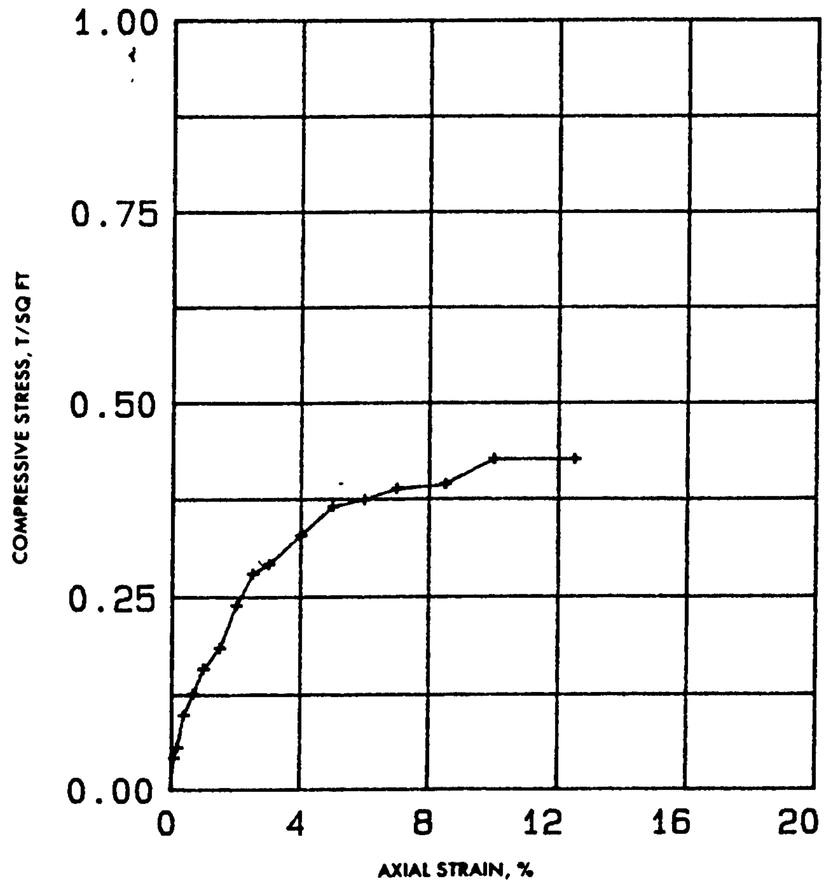
Table 9 - Triaxial $\bar{R}$ Test Results

Project : CHASKA; CENCS-IA-90-78-ED-GH
Boring Number : 90-139 MU
Sample Number : S-1
Depth : 14'-16'
Confining Pressure : 2 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.10	1.071	0.178	1.587	0.166	2.087	0.462
30	0.24	2.143	0.364	2.310	0.170	2.167	0.925
45	0.43	2.770	0.530	2.885	0.192	2.156	1.196
60	0.65	3.096	0.617	3.239	0.200	2.149	1.336
90	0.82	3.439	0.644	3.536	0.188	2.208	1.484
120	1.04	3.745	0.635	3.743	0.170	2.292	1.616
150	1.26	4.013	0.604	3.876	0.151	2.390	1.732
180	1.57	4.537	0.529	4.083	0.117	2.594	1.958
210	1.93	5.054	0.431	4.221	0.086	2.820	2.181
240	2.29	5.550	0.283	4.231	0.051	3.091	2.395
300	2.66	6.076	0.117	4.226	0.020	3.387	2.622
360	3.02	6.530	0.003	4.270	0.001	3.614	2.818
420	3.40	7.029	-0.160	4.254	-0.022	3.900	3.034
480	4.13	7.833	-0.412	4.247	-0.052	4.351	3.381
[illegible]40	4.90	8.737	-0.744	4.184	-0.085	4.907	3.771
[illegible]0	5.67	9.292	-0.901	4.203	-0.097	5.201	4.010
720	6.47	10.081	-1.254	4.098	-0.124	5.750	4.351
840	7.24	10.711	-1.500	4.060	-0.140	6.152	4.623
960	7.99	11.268	-1.746	4.008	-0.154	6.536	4.863
1080	9.56	12.242	-2.180	3.929	-0.178	7.211	5.284
1200	11.05	13.015	-2.454	3.922	-0.188	7.676	5.617
1320	12.53	13.627	-1.892	4.502	-0.138	7.266	5.882
1440	14.09	13.965	-1.579	4.902	-0.113	7.036	6.027
1511	15.00	14.169	-1.344	5.253	-0.095	6.852	6.115

FAILURE SKETCHES





☐ CONTROLLED STRESS

☒ CONTROLLED STRAIN

TEST NO.						
TYPE OF SPECIMEN UNDISTURBED						
INITIAL	WATER CONTENT	w_o	41.6 %	%	%	%
	VOID RATIO	e_o	1.08			
	SATURATION	S_o	100 %	%	%	%
	DRY DENSITY, LB/CU FT	γ_d	79.7			
TIME TO FAILURE, MIN		t_f	25.8			
UNCONFINED COMPRESSIVE STRENGTH, T/SQ FT		q_u	0.43			
UNDRAINED SHEAR STRENGTH, T/SQ FT		s_u	0.21			
SENSITIVITY RATIO		S_t				
INITIAL SPECIMEN DIAMETER, IN		D_o	1.40			
INITIAL SPECIMEN HEIGHT, IN.		H_o	2.98			

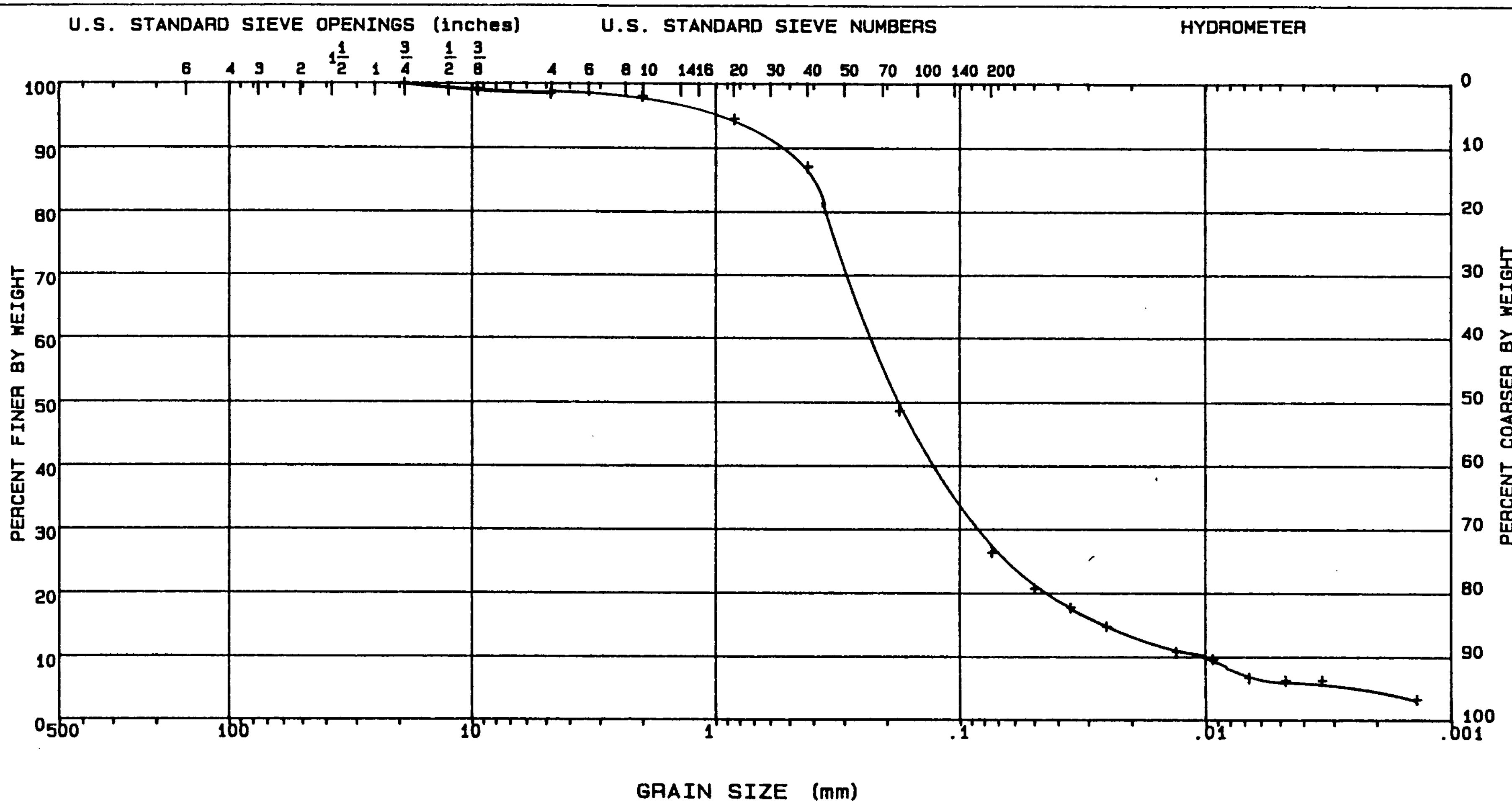
CLASSIFICATION Silty sand, SM

LL	PL	PI	G.
20	16	4	2.65

REMARKS Gray brown. Too soft for Torvane. Non-calcareous.

PROJECT	CHASKA; CENCS-IA-90-78-ED-GH
AREA	MRD LAB NO. : 90/358
BORING NO.	90-139 MU
SAMPLE NO.	S-1
DEPTH EL	14'-16'
DATE	09-10-90

UNCONFINED COMPRESSION TEST REPORT



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

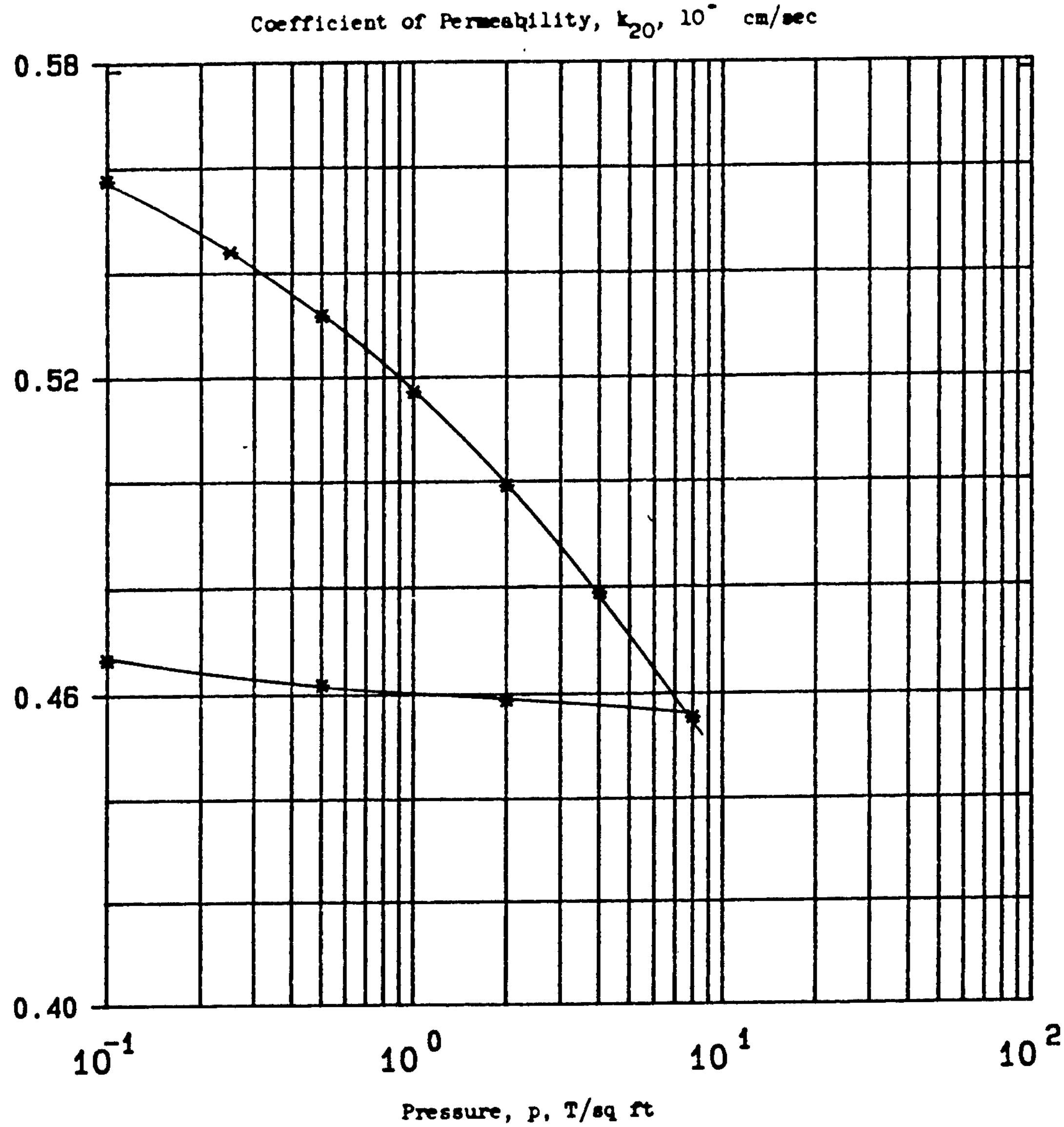
LL = 20	PL = 16	PI = 4	Gs = 2.65	NAT w = %

CLASSIFICATION Silty sand, SM

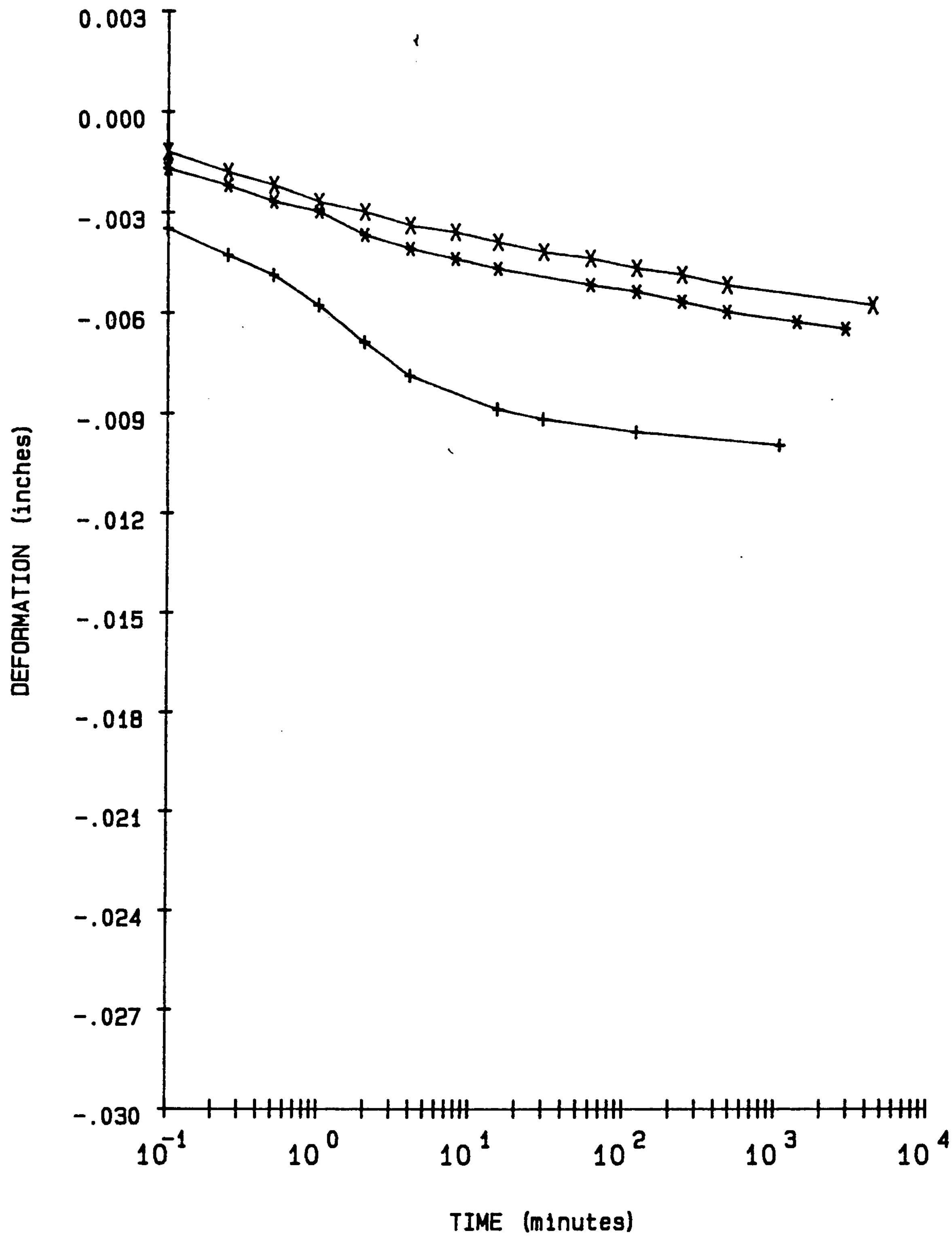
GRADATION CURVE

PROJECT	CHASKA; CENCS-IA-90-78-ED-GH
DATE	09-13-90
BORING NO.	90-139 MU
SAMPLE NO.	S-1
DEPTH/ELEV	14'-16'
MRD LAB NO.	90/358

FIGURE 23



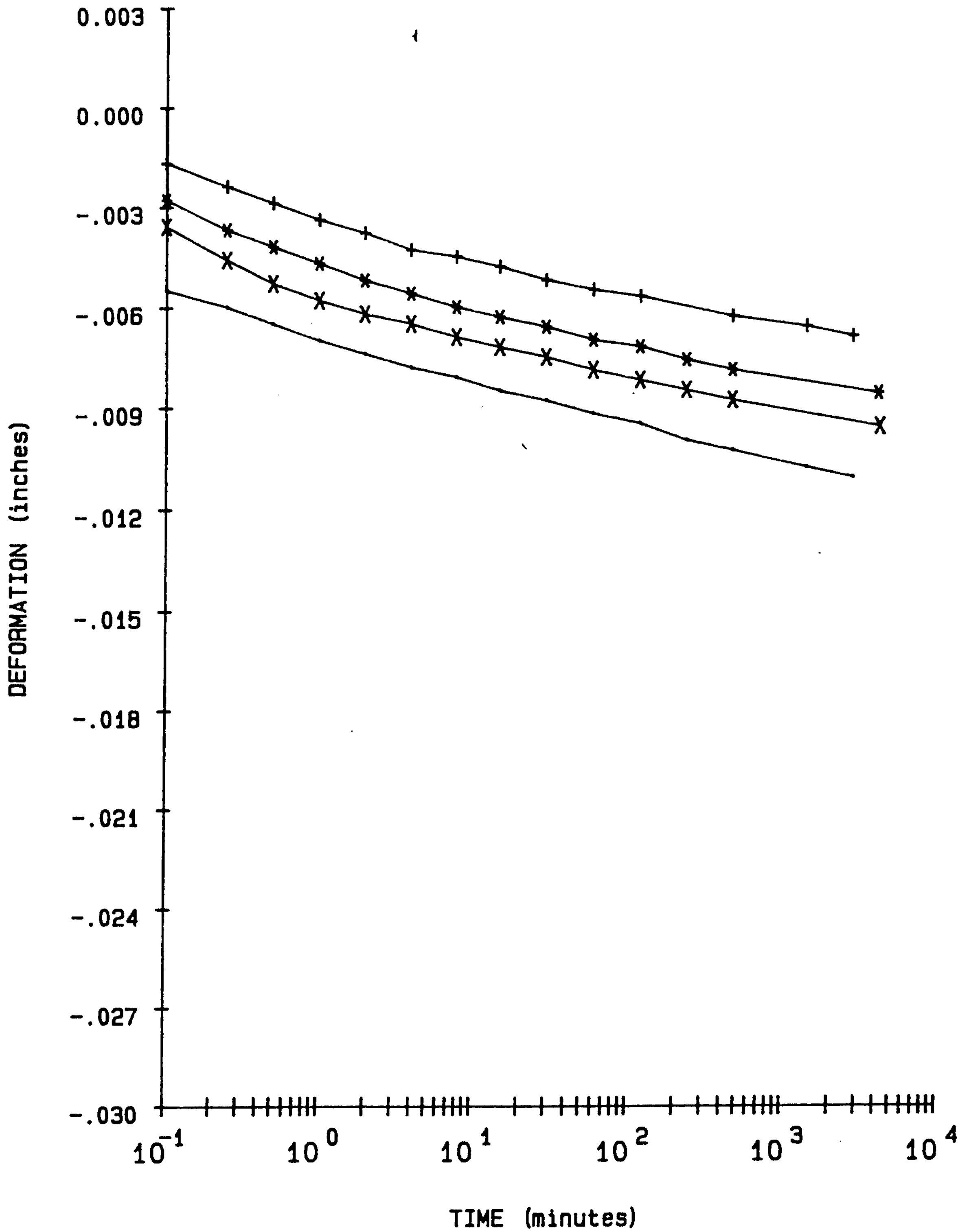
Type of Specimen UNDISTURBED		Before Test	After Test
Diam 2.5 in.	Ht .75 in.	Water Content, w_o 21.5 %	w_f 19.0 %
Overburden Pressure, p_o T/sq ft		Void Ratio, e_o 0.58	e_f 0.47
Preconsol. Pressure, p_c T/sq ft		Saturation, S_o 99 %	S_f 100 %
Compression Index, C_c		Dry Density, γ_d 105.1 lb/ft^3	
Classification Clayey sand, ~~CL~~ SC		k_{20} at e_o = × 10- cm/sec	
LL 24	G_s 2.66	Project CHASKA; CENCS-IA-90-78-ED-6H	
PL 15	D_{10}		
Remarks Gray. Torvane=0.25 TSF.		Area MRD LAB NO. 90/358	
Non-calcareous.		Boring No. 90-139 MU	Sample No. S-2
		Depth El 19'-20.8'	Date 09-11-90
		CONSOLIDATION TEST REPORT	



LEGEND	
+ = .1 TSF Wet	
* = .25 TSF	
X = .5 TSF	

PROJECT	CHASKA: CENCS-IA-90-78-ED-GH
BORING NO.	90-139 MU
SAMPLE NO.	S-2
DEPTH/ELEV	19'-20.8'
MRD LAB NO.	90/358

FIGURE 25



LEGEND	
+ = 1	TSF
* = 2	TSF
X = 4	TSF
- = 8	TSF

PROJECT	CHASKA: CENCS-IA-90-78-ED-GH
BORING NO.	90-139 MU
SAMPLE NO.	S-2
DEPTH/ELEV	19'-20.8'
MRD LAB NO.	90/358

FIGURE 26

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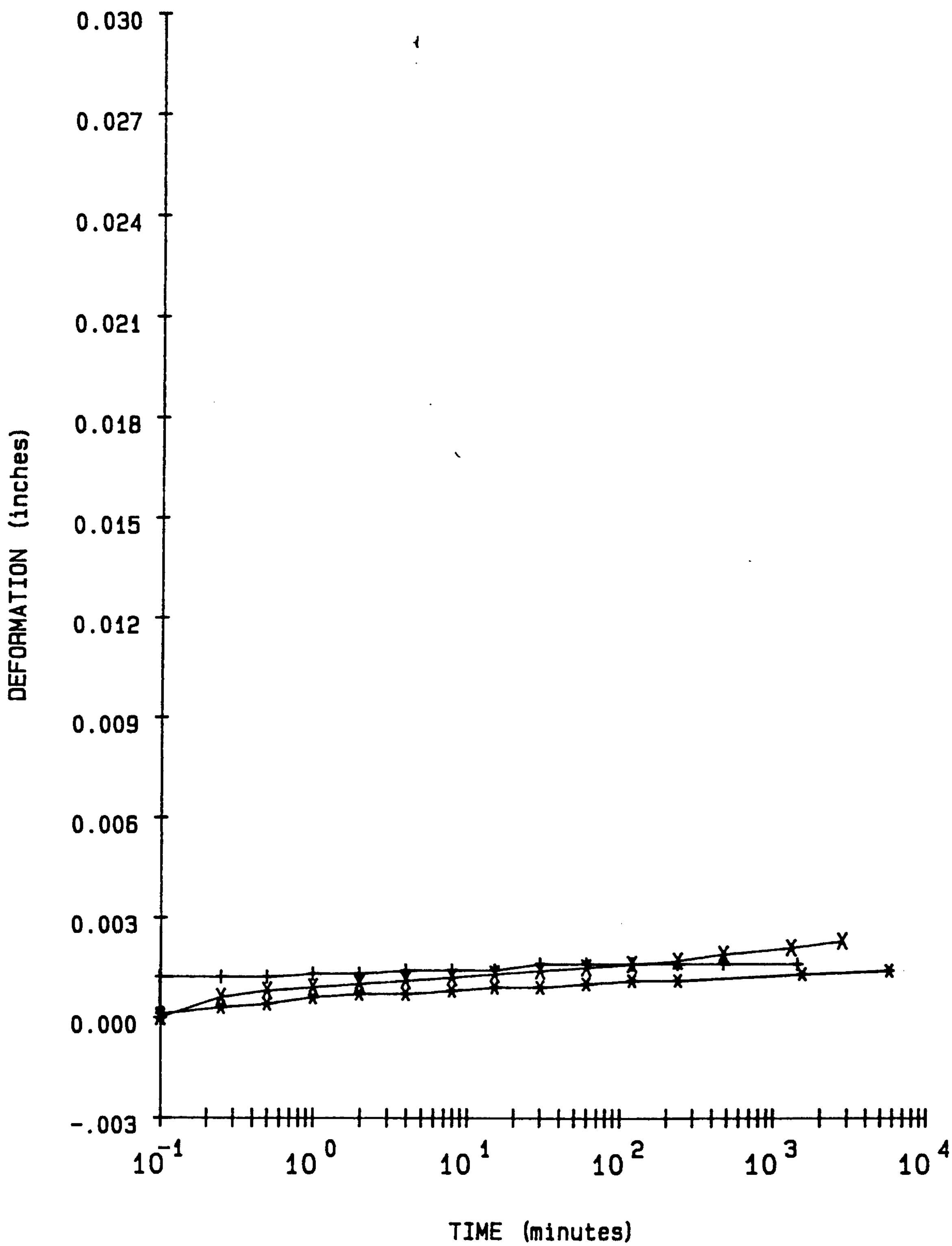


LEGEND

+ = 2 TSF Rebound
* = .5 TSF Rebound
X = .1 TSF Rebound

PROJECT	CHASKA; CENCS-IA-90-78-ED-GH
BORING NO.	90-139 MU
SAMPLE NO.	S-2
DEPTH/ELEV	19'-20.8'
MRD LAB NO.	90/358

FIGURE 27

Consolidation Test Data

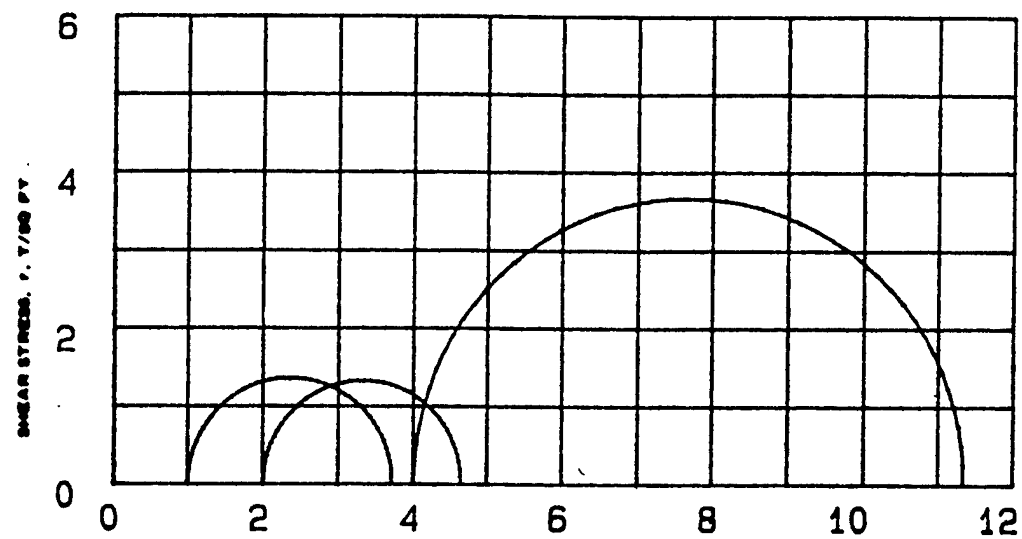
Project CHASKA; CENCS-IA-90-78-ED-GH

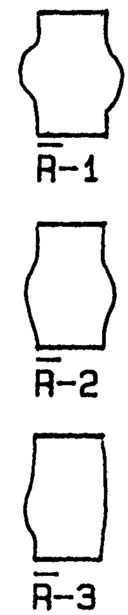
Boring No. 90-139 MU
Sample No. S-2
Depth/Elev 19'-20.8'
MRD Lab No. 90/358

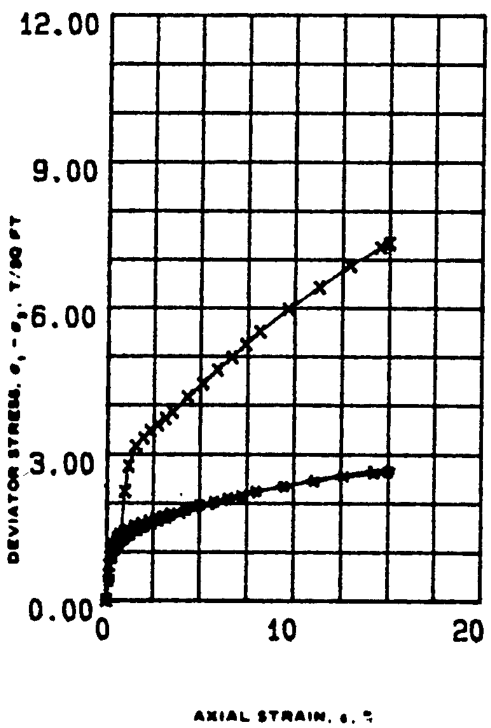
Gs = 2.66
eo = 0.579
0.42eo = 0.243

Water Content (%)	Dry Weight (gms)	Dry Density (PCF)	Void Ratio	Pressure (TSF)	Saturation (%)
21.5	101.7	105.1	0.579		98.8
19.0	101.7	106.6	0.558	0.10	90.5
19.0	101.7	107.5	0.544	0.25	92.8
19.0	101.7	108.4	0.532	0.50	94.9
19.0	101.7	109.4	0.517	1.00	97.6
19.0	101.7	110.7	0.499	2.00	100.0
19.0	101.7	112.2	0.479	4.00	100.0
19.0	101.7	114.0	0.455	8.00	100.0
19.0	101.7	113.8	0.459	2.00	100.0
19.0	101.7	113.6	0.462	0.50	100.0
19.0	101.7	113.2	0.467	0.10	100.0

Axial Strain (%)	Void Ratio
1	0.563
2	0.547
3	0.531
4	0.515
5	0.500
6	0.484
7	0.468
8	0.452
9	0.436
10	0.421







SPECIMEN NO.		1 (+)	2 (*)	3 (X)	
INITIAL: WATER CONTENT, %	w_o	22.5	23.5	23.7	
INITIAL: DRY DENSITY LB/CU FT	γ_{d_o}	107.9	105.1	108.4	
INITIAL: SATURATION, %	S_o	100	100	100	
INITIAL: VOID RATIO	e_o	.54	.58	.56	
BEFORE SHEAR: WATER CONTENT, %	w_c	19.3	19.5	17.9	
BEFORE SHEAR: DRY DENSITY LB/CU FT	γ_{d_c}	109.6	109.7	113.2	
BEFORE SHEAR: SATURATION, %	S_c	100	100	100	
BEFORE SHEAR: VOID RATIO	e_c	.52	.51	.47	
BEFORE SHEAR: FINAL BACK PRESSURE, T/SQ FT	u_o	5.543	5.543	5.543	
MINOR PRINCIPAL STRESS, T/SQ FT	σ_3	1	2	4	
MAXIMUM DEVIATOR STRESS, T/SQ FT	$(\sigma_1 - \sigma_3)_{max}$	2.717	2.649	7.340	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN	t_f	1512	1498	1476	
ULTIMATE DEVIATOR STRESS, T/SQ FT	$(\sigma_1 - \sigma_3)_{ult}$	2.717	2.649	7.340	
INITIAL DIAMETER, IN.	D_o	1.38	1.37	1.36	
INITIAL HEIGHT, IN.	H_o	2.96	2.95	2.91	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Clayey sand, ~~CL~~ SC B-Value . 1.0 1.0 1.0

LL 24	PL 15	PI 9	G_s 2.66

TYPE OF SPECIMEN UNDISTURBED TYPE OF TEST RBAR

REMARKS: Gray. Torvane=0.25 TSF.
Non-calcareous. The results are questionable due to pressure loss during consolidation.

PROJECT CHASKA: CENCS-IA-90-78-ED-6H

BORING NO. 90-139 MU SAMPLE NO. S-2

DEPTH ELEV 19'-20.8'

LABORATORY 90/358 DATE 09-18-90

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)
REV JUNE 1970

FIGURE 28

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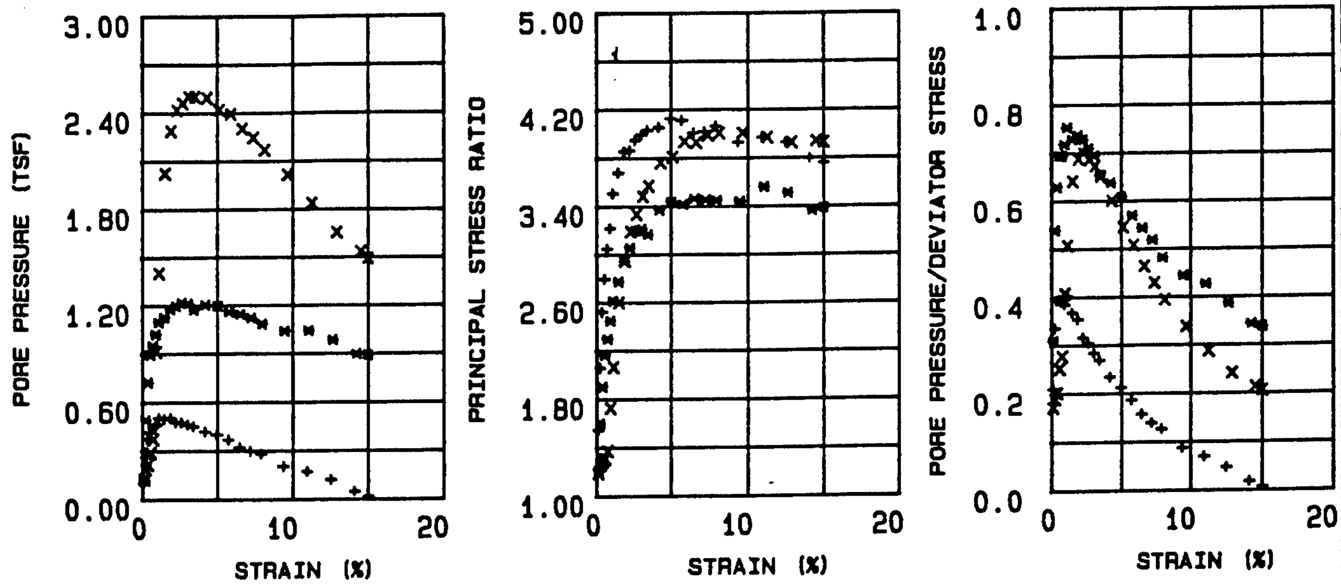
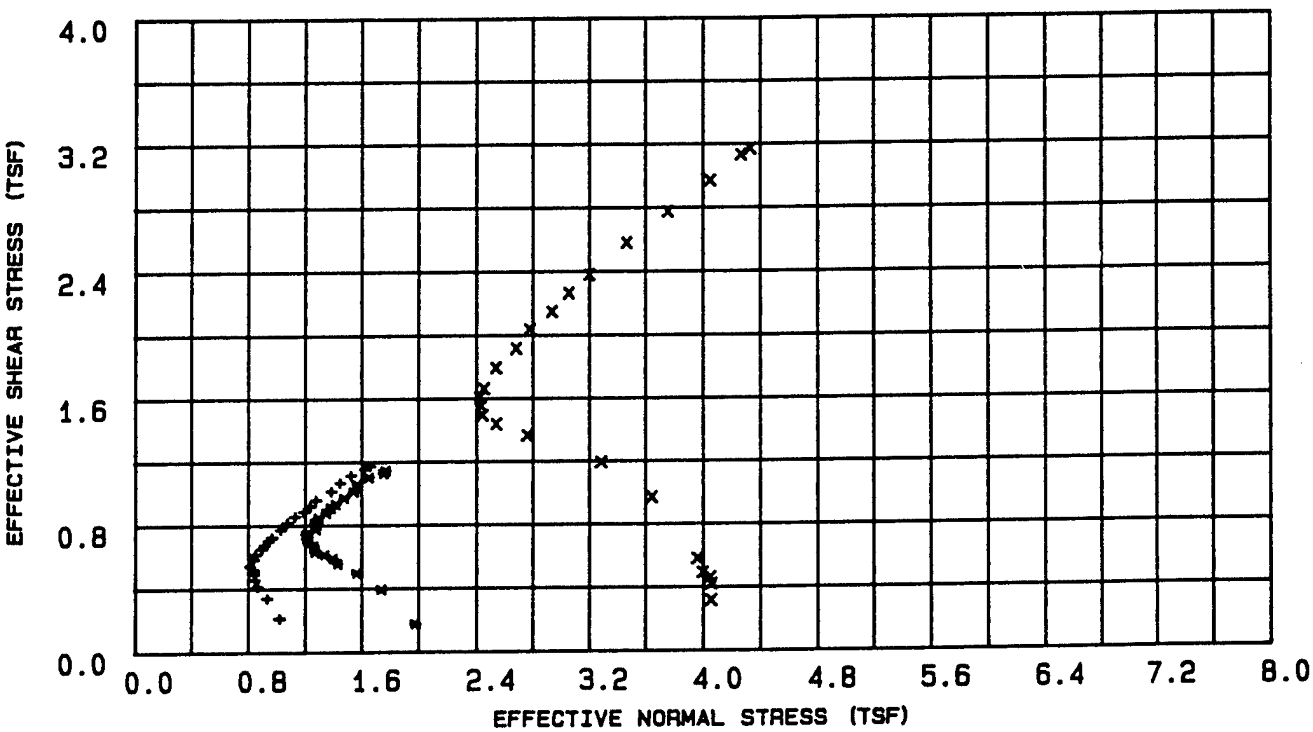


EFFECTIVE STRESS VECTOR CURVES ON 60 DEGREE PLANE



LEGEND

+ = 1 TSF

✻ = 2 TSF

X = 4 TSF

PROJECT	CHASKA: CENCS-IA-90-78-ED-6H
BORING NO.	90-139 MU
SAMPLE NO.	S-2
DEPTH/ELEV	19'-20.8'
MRD LAB NO.	90/358

FIGURE 29

R

Table 10 - Triaxial $\bar{R}$ Test Results

Project : CHASKA; CENCS-IA-90-78-ED-GH
Boring Number : 90-139 MU
Sample Number : S-2
Depth : 19'-20.8'
Confining Pressure : 1 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.15	0.487	0.102	1.542	0.209	1.019	0.210
30	0.26	0.780	0.261	2.056	0.335	0.932	0.337
45	0.41	0.952	0.373	2.520	0.393	0.863	0.411
60	0.58	1.050	0.414	2.793	0.395	0.846	0.453
90	0.75	1.139	0.444	3.046	0.390	0.838	0.491
120	0.94	1.199	0.459	3.217	0.384	0.838	0.517
150	1.13	1.249	0.501	3.505	0.402	0.808	0.539
180	1.49	1.351	0.495	3.675	0.367	0.839	0.583
210	1.88	1.423	0.501	3.854	0.353	0.851	0.614
240	2.24	1.505	0.474	3.862	0.315	0.899	0.650
300	2.62	1.559	0.471	3.946	0.303	0.915	0.673
360	3.03	1.620	0.458	3.991	0.283	0.943	0.699
420	3.42	1.672	0.448	4.029	0.268	0.966	0.722
480	4.19	1.785	0.415	4.052	0.233	1.027	0.770
540	4.96	1.886	0.396	4.125	0.211	1.071	0.814
600	5.71	1.978	0.364	4.109	0.185	1.126	0.854
720	6.45	2.050	0.318	4.005	0.156	1.190	0.885
840	7.17	2.130	0.294	4.016	0.138	1.233	0.919
960	7.90	2.217	0.276	4.062	0.125	1.273	0.957
1080	9.37	2.344	0.199	3.927	0.086	1.381	1.012
1200	10.93	2.470	0.167	3.964	0.068	1.444	1.066
1320	12.49	2.581	0.117	3.925	0.046	1.522	1.114
1440	14.06	2.671	0.043	3.791	0.017	1.618	1.153
1512	15.00	2.717	0.013	3.752	0.006	1.659	1.172

Table 11 - Triaxial $\overline{R}$ Test Results

Project : CHASKA; CENCS-IA-90-78-ED-GH
Boring Number : 90-139 MU
Sample Number : S-2
Depth : 19'-20.8'
Confining Pressure : 2 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.15	0.400	0.124	1.213	0.309	1.975	0.173
30	0.27	0.908	0.489	1.601	0.539	1.736	0.392
45	0.42	1.149	0.722	1.899	0.629	1.562	0.496
60	0.58	1.288	0.893	2.163	0.694	1.426	0.556
90	0.76	1.365	0.947	2.296	0.694	1.391	0.589
120	0.95	1.421	1.020	2.449	0.718	1.332	0.613
150	1.14	1.457	1.096	2.612	0.753	1.265	0.629
180	1.51	1.548	1.126	2.771	0.728	1.257	0.668
210	1.90	1.599	1.176	2.941	0.736	1.220	0.690
240	2.27	1.649	1.197	3.054	0.727	1.211	0.712
300	2.66	1.718	1.218	3.197	0.709	1.207	0.742
360	3.07	1.746	1.211	3.214	0.694	1.221	0.754
420	3.46	1.795	1.171	3.165	0.653	1.273	0.775
480	4.24	1.890	1.202	3.370	0.637	1.266	0.816
540	5.02	1.964	1.194	3.436	0.608	1.292	0.848
600	5.78	2.037	1.157	3.417	0.569	1.347	0.879
720	6.53	2.109	1.143	3.462	0.543	1.379	0.910
840	7.26	2.161	1.119	3.453	0.518	1.416	0.933
960	7.99	2.250	1.081	3.447	0.481	1.476	0.971
080	9.48	2.346	1.037	3.437	0.443	1.544	1.013
200	11.07	2.453	1.041	3.557	0.425	1.566	1.059
320	12.65	2.554	0.981	3.507	0.385	1.651	1.102
440	14.23	2.614	0.893	3.361	0.342	1.754	1.128
498	15.00	2.649	0.888	3.382	0.336	1.768	1.144

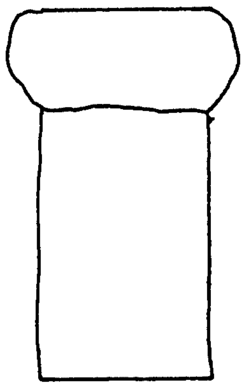
Table 12- Triaxial $\bar{R}$ Test Results

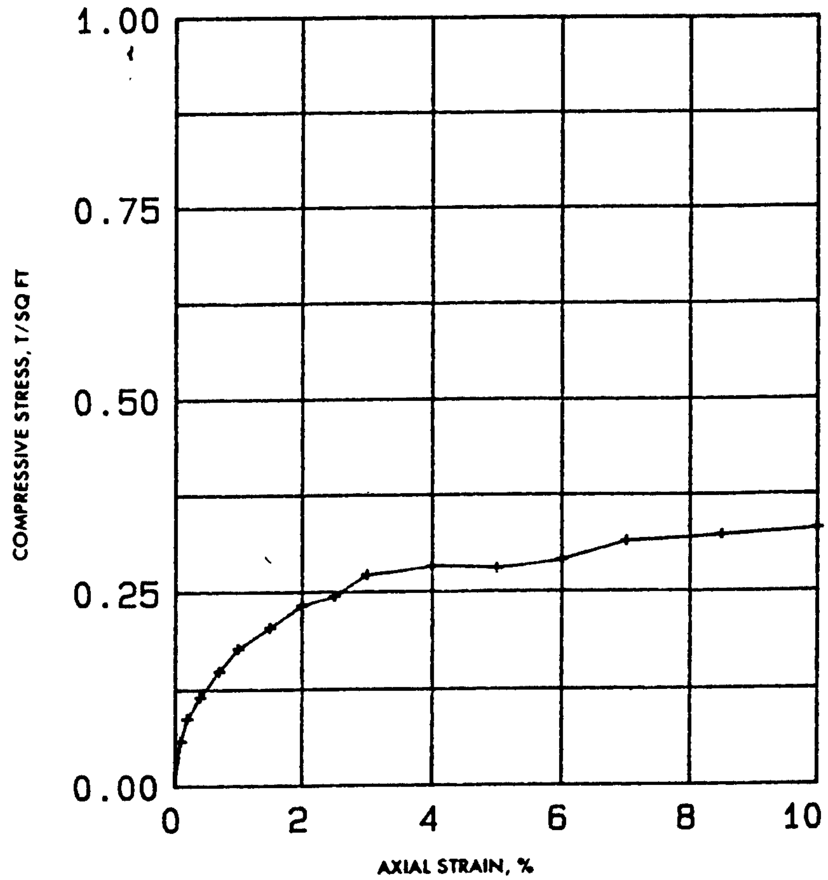
Project : CHASKA; CENCS-IA-90-78-ED-GH
Boring Number : 90-139 MU
Sample Number : S-2
Depth : 19'-20.8'
Confining Pressure : 4 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.15	0.724	0.123	1.187	0.171	4.056	0.313
30	0.27	0.969	0.183	1.254	0.189	4.057	0.418
45	0.42	1.061	0.213	1.280	0.201	4.050	0.458
60	0.60	1.134	0.284	1.305	0.251	3.997	0.489
90	0.77	1.338	0.369	1.369	0.277	3.962	0.578
120	0.97	2.240	0.911	1.725	0.407	3.644	0.967
150	1.17	2.761	1.400	2.062	0.507	3.284	1.192
180	1.54	3.160	2.023	2.598	0.641	2.759	1.364
210	1.94	3.331	2.288	2.945	0.687	2.537	1.437
240	2.31	3.463	2.418	3.190	0.699	2.439	1.495
300	2.71	3.594	2.460	3.333	0.685	2.430	1.551
360	3.13	3.722	2.501	3.482	0.672	2.420	1.606
420	3.53	3.850	2.501	3.567	0.650	2.452	1.662
480	4.32	4.157	2.493	3.758	0.600	2.536	1.794
540	5.12	4.440	2.418	3.807	0.545	2.681	1.916
600	5.89	4.719	2.392	3.935	0.507	2.776	2.037
720	6.66	4.975	2.299	3.925	0.463	2.933	2.147
840	7.40	5.246	2.243	3.986	0.428	3.056	2.264
960	8.15	5.512	2.165	4.003	0.393	3.200	2.379
1080	9.67	5.974	2.012	4.004	0.337	3.467	2.578
1200	11.28	6.426	1.833	3.965	0.286	3.758	2.773
1320	12.90	6.874	1.650	3.924	0.240	4.052	2.967
1440	14.51	7.251	1.530	3.936	0.212	4.265	3.130
1476	15.00	7.340	1.489	3.923	0.204	4.329	3.168

FIGURE D-133

FAILURE SKETCHES





☐ CONTROLLED STRESS

☒ CONTROLLED STRAIN

TEST NO.						
TYPE OF SPECIMEN UNDISTURBED						
INITIAL	WATER CONTENT	w_o	18.0 %	%	%	%
	VOID RATIO	e_o	0.60			
	SATURATION	S_o	80 %	%	%	%
	DRY DENSITY, LB/CU FT	γ_d	103.7			
TIME TO FAILURE, MIN		t_f	21.3			
UNCONFINED COMPRESSIVE STRENGTH, T/SQ FT		q_u	0.33			
UNDRAINED SHEAR STRENGTH, T/SQ FT		s_u				
SENSITIVITY RATIO		S_t				
INITIAL SPECIMEN DIAMETER, IN		D_o	1.38			
INITIAL SPECIMEN HEIGHT, IN.		H_o	3.01			

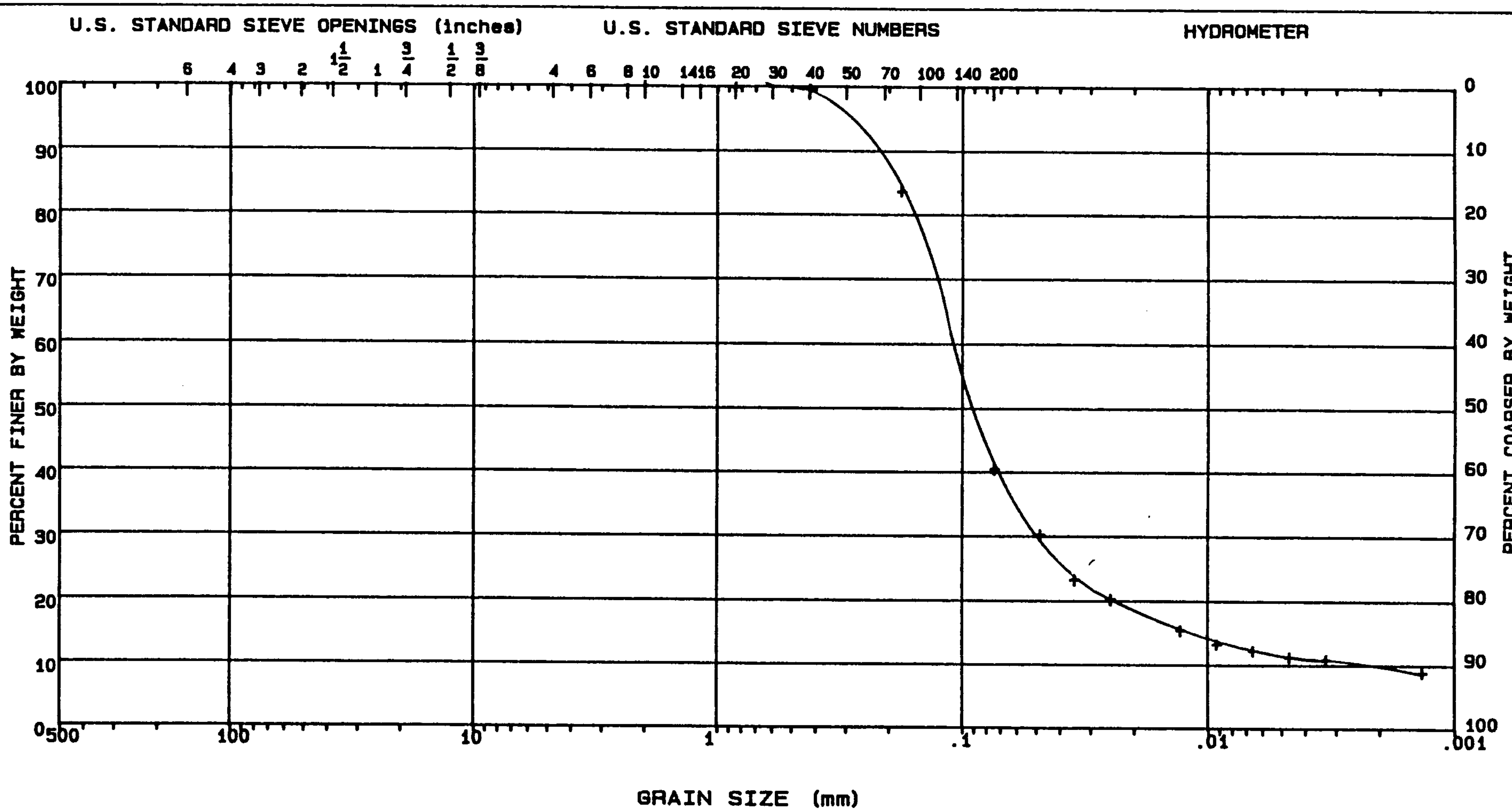
CLASSIFICATION Clayey sand, ~~CL~~ SC

LL	PL	PI	G.
24	15	9	2.66

REMARKS Gray. Torvane=0.25 TSF. Non-calcareous.

PROJECT	CHASKA; CENCS-IA-90-78-ED-GH		
AREA	MRD LAB NO. : 90/358		
BORING NO.	90-139 MU	SAMPLE NO.	S-2
DEPTH EL	19'-20.8'	DATE	09-19-90

UNCONFINED COMPRESSION TEST REPORT



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

LL = 24	PL = 15	PI = 9	Gs = 2.66	NAT w = %

CLASSIFICATION Clayey sand, ~~OL~~ SC

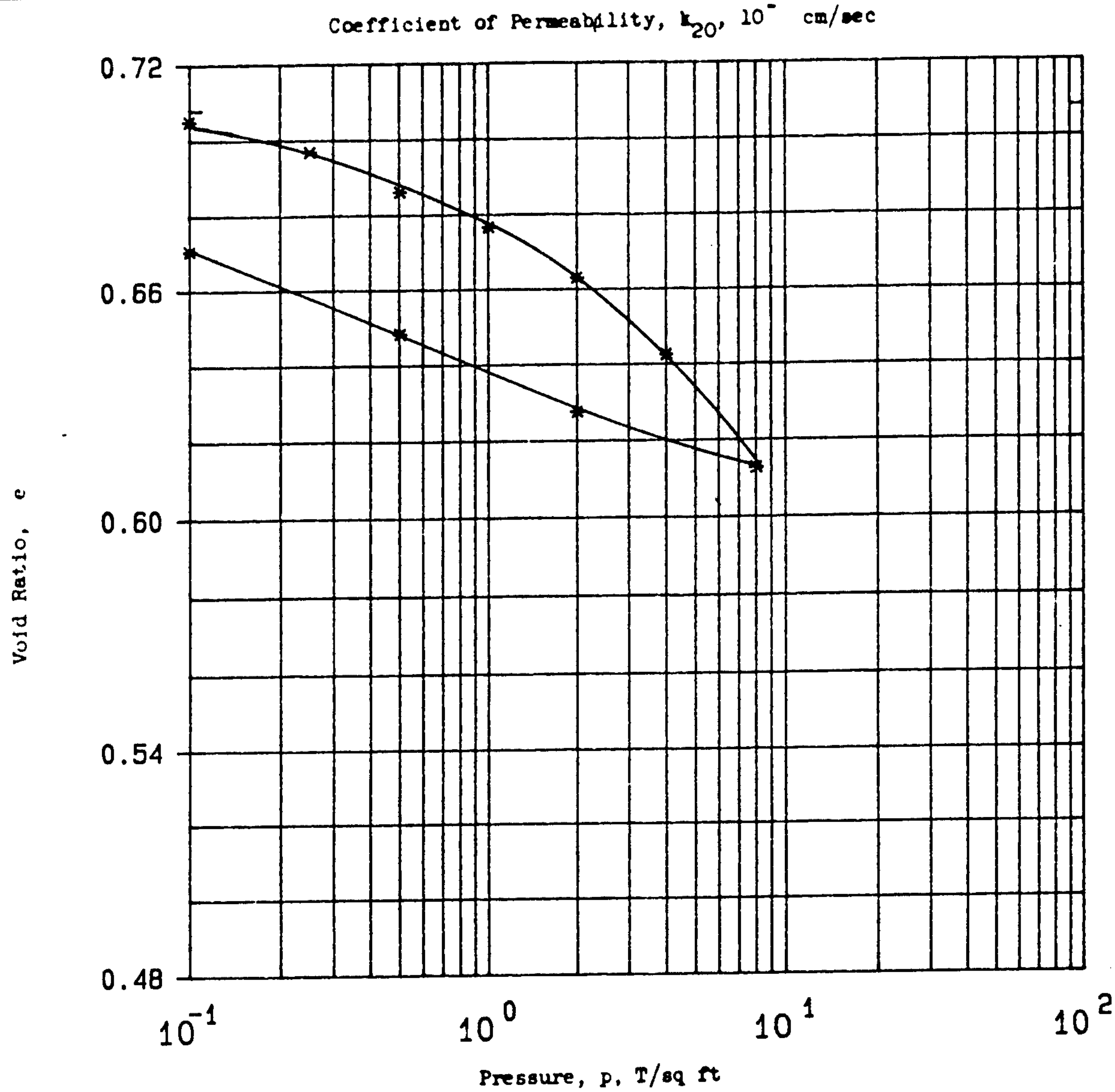
PROJECT	CHASKA: CENCS-IA-90-78-ED-GH
DATE	09-19-90
BORING NO.	90-139 MU
SAMPLE NO.	S-2
DEPTH/ELEV	19'-20.8'
MRD LAB NO.	90/358

GRADATION CURVE

FIGURE 31

FIGURE D-135

134

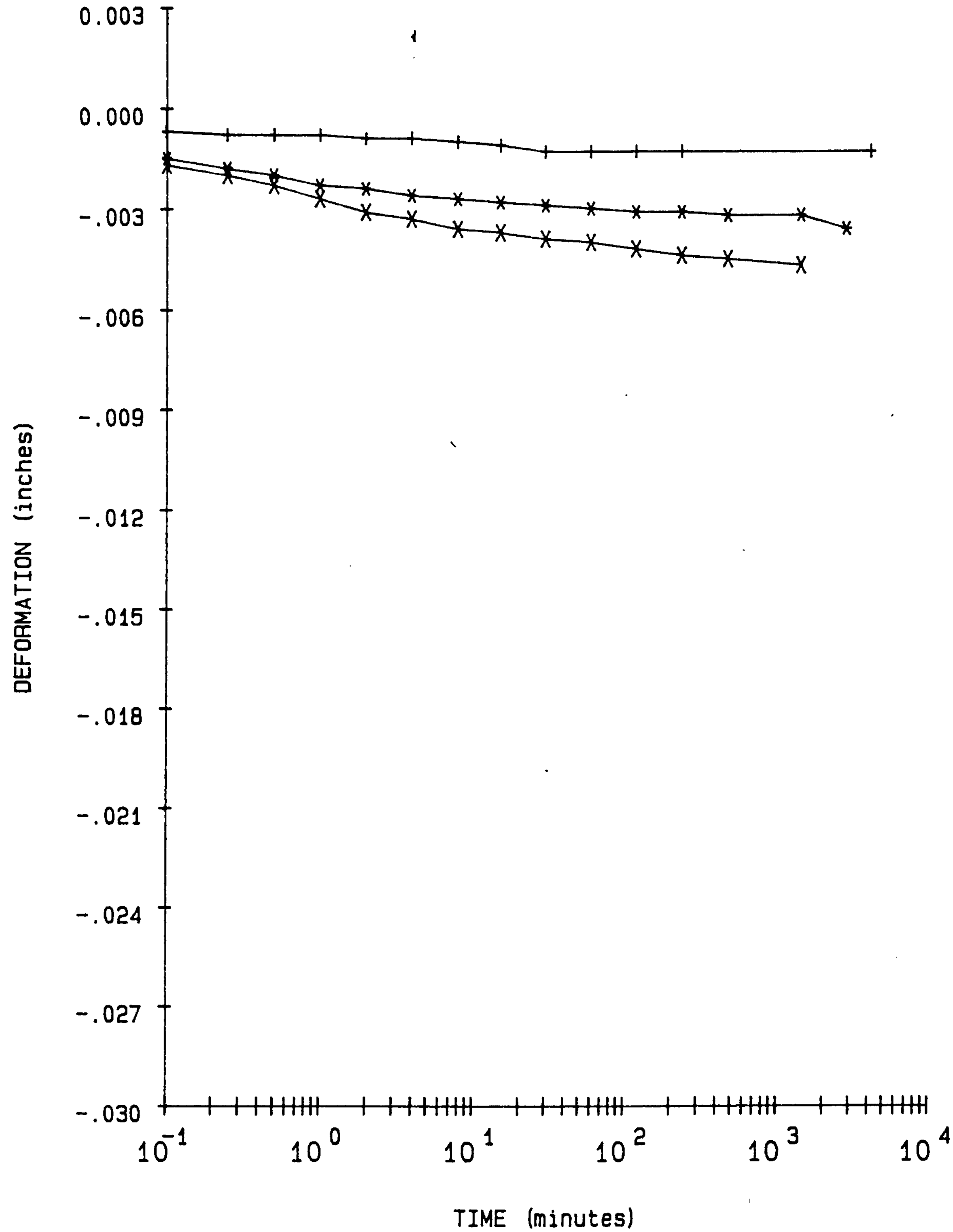


Type of Specimen UNDISTURBED		Before Test		After Test	
Diam 2.5 in.	Ht .75 in.	Water Content, w_o	26.9 %	w_f	24.6 %
Overburden Pressure, Po T/sq ft		Void Ratio, e_o	0.71	e_f	0.67
Preconsol. Pressure, Pc T/sq ft		Saturation, S_o	100 %	S_f	100 %
Compression Index, C_c		Dry Density, γ_d	99.0 lb/ft^3		
Classification Lean clay, CL		k_{20} at e_o = × 10^{-} cm/sec			
LL 44	G_s 2.71	Project	CHASKA; CENCS-IA-90-78-ED-GH		
PL 20	D_{10}				
Remarks Gray brown. Torvane=1.25		Area	MRD LAB NO. 90/358		
TSF. Highly calcareous.		Boring No.	90-139 MU	Sample No.	S-3
		Depth El	31'-33'	Date	09-21-90

CONSOLIDATION TEST REPORT

ENG FORM 1 MAY 63 2090 PREVIOUS EDITIONS ARE OBSOLETE.

Figure 1

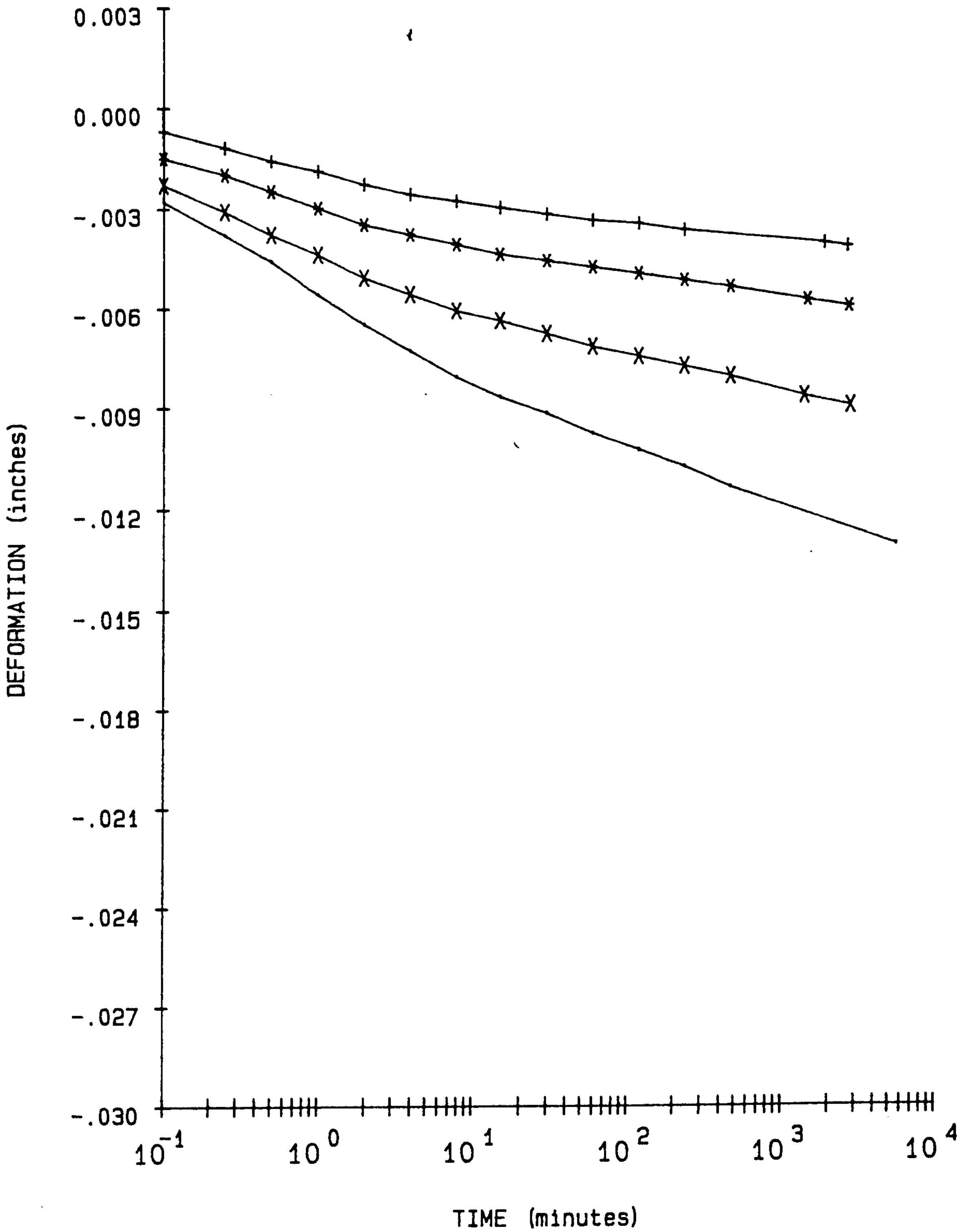


LEGEND

+ = .1 TSF Wet
* = .25 TSF
X = .5 TSF

PROJECT	CHASKA: CENCS-IA-90-78-ED-GH
BORING NO.	90-139 MU
SAMPLE NO.	S-3
DEPTH/ELEV	31'-33'
MRD LAB NO.	90/358

FIGURE 2

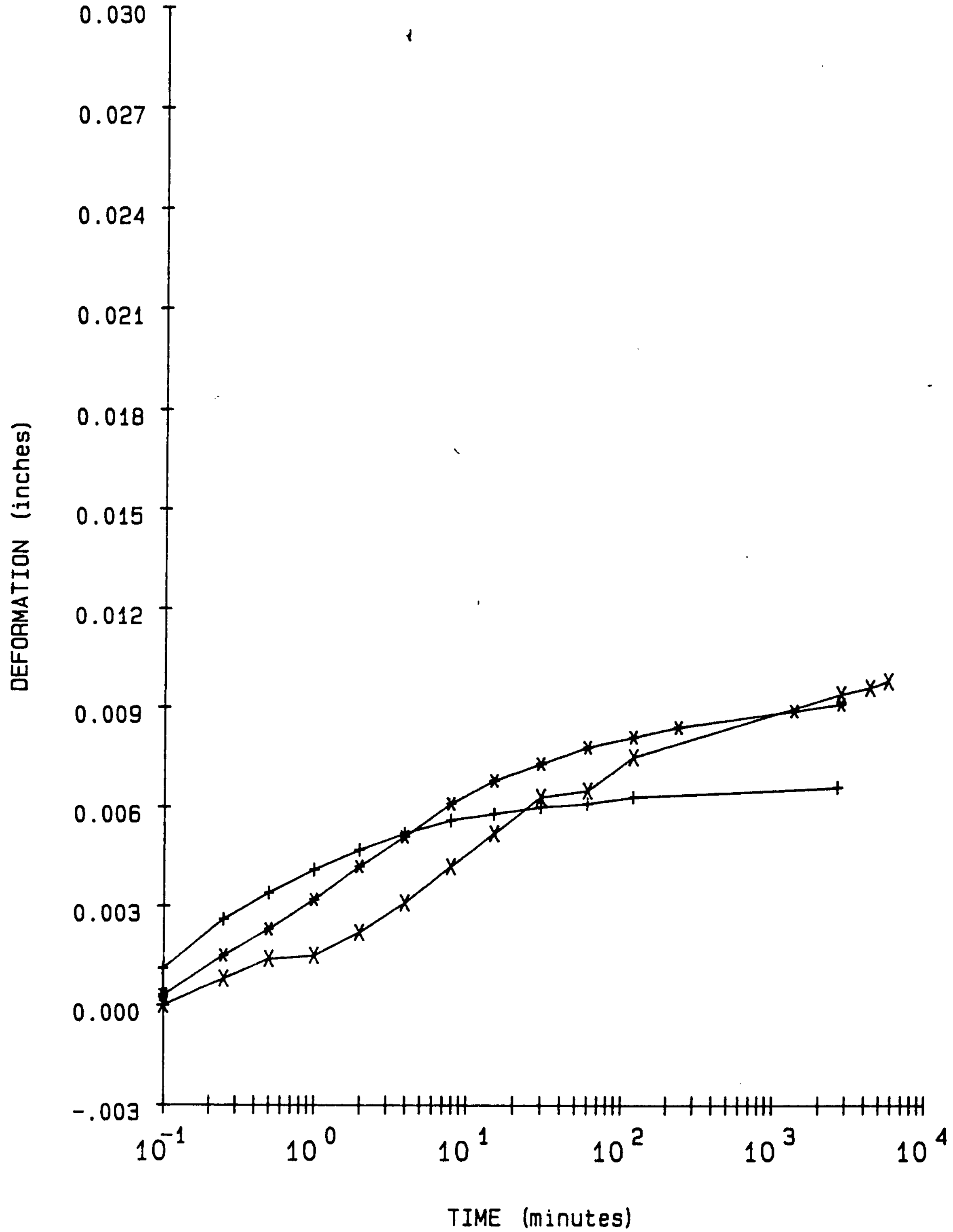


LEGEND

+ = 1 TSF
* = 2 TSF
X = 4 TSF
- = 8 TSF

PROJECT	CHASKA: CENCS-IA-90-78-ED-GH
BORING NO.	90-139 MU
SAMPLE NO.	S-3
DEPTH/ELEV	31'-33'
MRD LAB NO.	90/358

FIGURE 3



LEGEND		
+ = 2	TSF	Rebound
* = .5	TSF	Rebound
X = .1	TSF	Rebound

PROJECT	CHASKA: CENCS-IA-90-78-ED-GH
BORING NO.	90-139 MU
SAMPLE NO.	S-3
DEPTH/ELEV	31'-33'
MRD LAB NO.	90/358

FIGURE 4

Consolidation Test Data

Project CHASKA; CENCS-IA-90-78-ED-GH

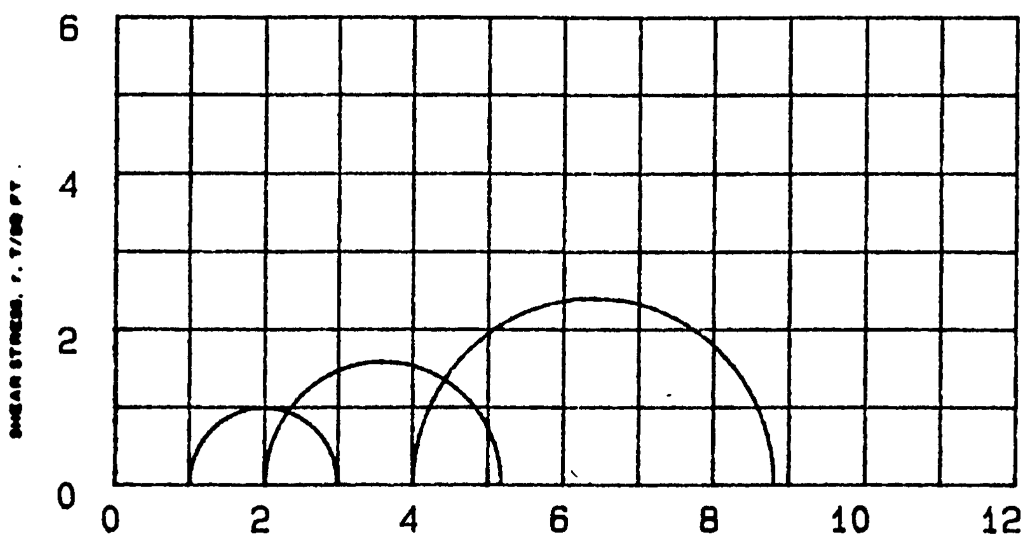
Boring No. 90-139 MU
Sample No. S-3
Depth/Elev 31'-33'
MRD Lab No. 90/358

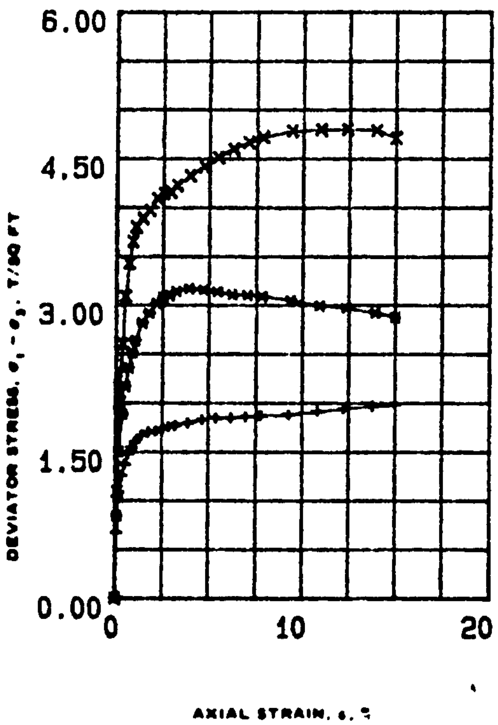
Gs = 2.71
eo = 0.708
0.42eo = 0.297

Water Content (%)	Dry Weight (gms)	Dry Density (PCF)	Void Ratio	Pressure (TSF)	Saturation (%)
26.9	95.7	99.0	0.708		100.0
24.6	95.7	99.2	0.705	0.10	94.7
24.6	95.7	99.7	0.697	0.25	95.8
24.6	95.7	100.3	0.686	0.50	97.3
24.6	95.7	100.9	0.677	1.00	98.7
24.6	95.7	101.7	0.663	2.00	100.0
24.6	95.7	103.0	0.642	4.00	100.0
24.6	95.7	104.9	0.613	8.00	100.0
24.6	95.7	103.9	0.628	2.00	100.0
24.6	95.7	102.6	0.648	0.50	100.0
24.6	95.7	101.2	0.671	0.10	100.0

Axial Strain (%)	Void Ratio
1	0.691
2	0.674
3	0.657
4	0.640
5	0.623
6	0.605
7	0.588
8	0.571

FIGURE D-140





SPECIMEN NO.			1 (+)	2 (*)	3 (X)
INITIAL	WATER CONTENT, %	w_o	28	28.4	26
INITIAL	DRY DENSITY LB/CU FT	γ_{d_o}	94.3	95.5	101.1
INITIAL	SATURATION, %	S_o	96	100	100
INITIAL	VOID RATIO	e_o	.79	.77	.67
BEFORE SHEAR	WATER CONTENT, %	w_c	28.5	28.6	26.4
BEFORE SHEAR	DRY DENSITY LB/CU FT	γ_{d_c}	98	98	104.9
BEFORE SHEAR	SATURATION, %	S_c	100	100	100
BEFORE SHEAR	VOID RATIO	e_c	.73	.73	.61
BEFORE SHEAR	FINAL BACK PRESSURE, T/SQ FT	u_o	4.103	4.103	4.103
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1	2	4
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	1.983	3.170	4.797
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	1535	480	1320
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	1.983	2.871	4.707
INITIAL DIAMETER, IN.		D_o	1.41	1.41	1.39
INITIAL HEIGHT, IN.		H_o	3.03	2.99	2.99

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Lean clay, CL B-Value 1.0 1.0 1.0

LL 44 | PL 20 | PI 24 | G_s 2.71

TYPE OF SPECIMEN UNDISTURBED | TYPE OF TEST R̄BAR

REMARKS: Gray brown. Torvane=1.25 TSF
Highly calcareous.

PROJECT CHASKA; CENCS-IA-90-78-ED-6H

BORING NO 90-139 MU | SAMPLE NO. S-3

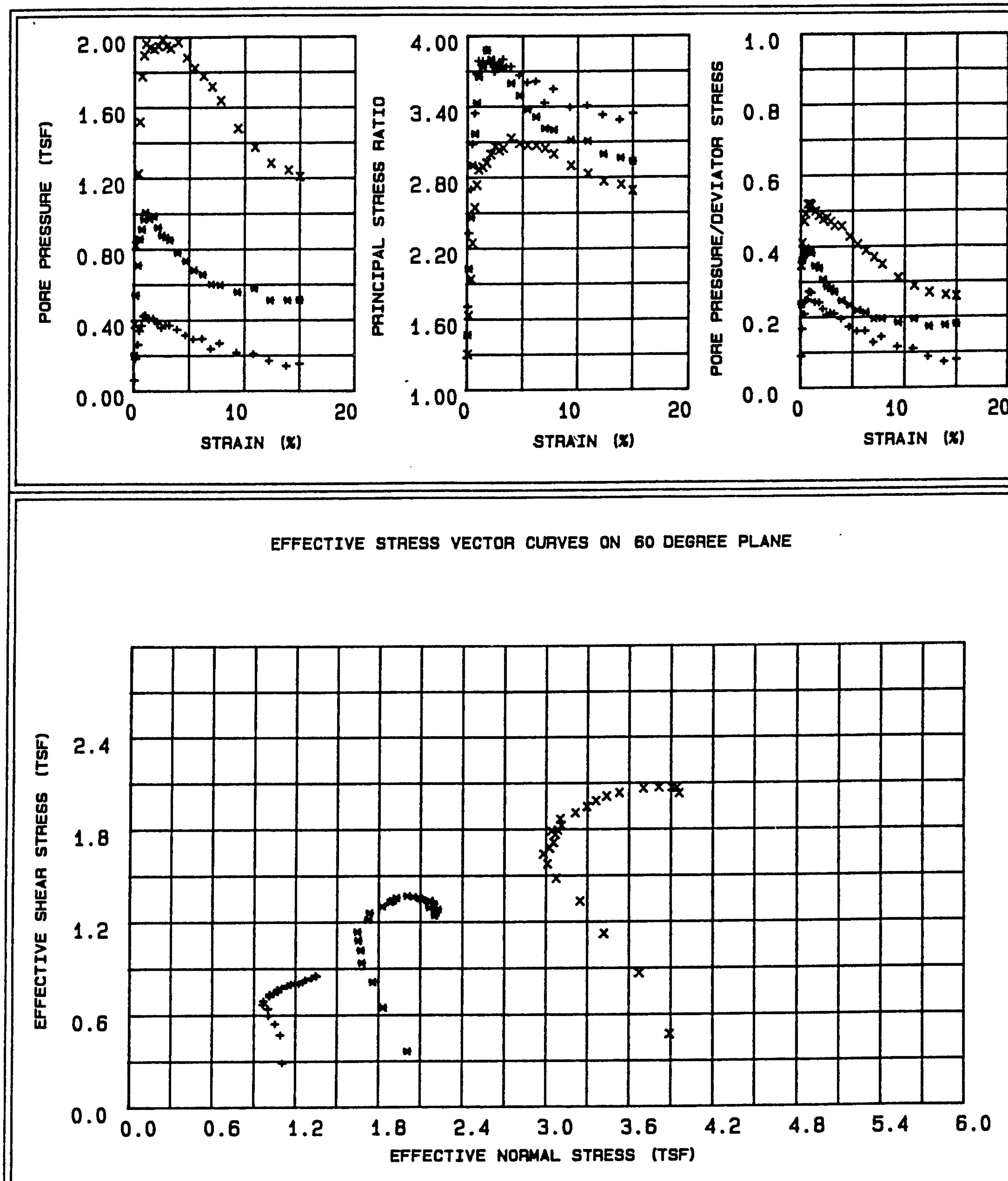
DEPTH ELEV 31'-33'

LABORATORY 90/358 | DATE 09-21-90

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

FIGURE 5



LEGEND

+ = 1 TSF
* = 2 TSF
X = 4 TSF

PROJECT	CHASKA; CENCS-IA-90-78-ED-8H
BORING NO.	90-139 MU
SAMPLE NO.	S-3
DEPTH/ELEV	31'-33'
MRD LAB NO.	90/358

FIGURE 6

R

Table 1 - Triaxial R̄ Test Results

Project : CHASKA; CENCS-IA-90-78-ED-GH
Boring Number : 90-139 MU
Sample Number : S-3
Depth : 31'-33'
Confining Pressure : 1 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.10	0.666	0.059	1.707	0.089	1.106	0.287
30	0.19	1.087	0.181	2.327	0.167	1.088	0.469
45	0.38	1.254	0.261	2.697	0.209	1.049	0.541
60	0.53	1.376	0.339	3.081	0.247	1.002	0.594
90	0.72	1.479	0.369	3.343	0.250	0.997	0.638
120	0.88	1.546	0.422	3.675	0.273	0.961	0.667
150	1.05	1.596	0.428	3.788	0.269	0.967	0.689
180	1.41	1.666	0.402	3.786	0.242	1.011	0.719
210	1.77	1.701	0.409	3.879	0.241	1.012	0.734
240	2.15	1.709	0.380	3.758	0.223	1.043	0.738
300	2.51	1.734	0.356	3.693	0.206	1.073	0.749
360	2.86	1.751	0.369	3.775	0.211	1.065	0.756
420	3.22	1.767	0.369	3.801	0.209	1.069	0.763
480	3.91	1.792	0.346	3.739	0.194	1.098	0.773
540	4.68	1.830	0.313	3.664	0.171	1.140	0.790
600	5.39	1.844	0.291	3.602	0.159	1.166	0.796
720	6.18	1.847	0.293	3.611	0.159	1.164	0.797
840	6.97	1.857	0.235	3.429	0.127	1.225	0.802
960	7.76	1.867	0.267	3.547	0.143	1.195	0.806
1080	9.28	1.879	0.214	3.390	0.114	1.251	0.811
1200	10.81	1.913	0.205	3.407	0.108	1.269	0.826
1320	12.24	1.940	0.167	3.327	0.086	1.313	0.837
1440	13.79	1.968	0.138	3.283	0.071	1.349	0.849
1534	15.00	1.983	0.151	3.337	0.077	1.340	0.856

Table 2 - Triaxial $\bar{R}$ Test Results

Project : CHASKA; CENCS-IA-90-78-ED-GH
Boring Number : 90-139 MU
Sample Number : S-3
Depth : 31'-33'
Confining Pressure : 2 TSF

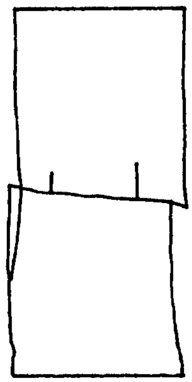
Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.10	0.841	0.199	1.467	0.237	2.009	0.363
30	0.19	1.501	0.540	2.028	0.361	1.832	0.648
45	0.38	1.885	0.710	2.461	0.377	1.757	0.813
60	0.53	2.171	0.858	2.901	0.396	1.680	0.937
90	0.72	2.359	0.912	3.169	0.387	1.672	1.018
120	0.89	2.508	0.968	3.430	0.386	1.653	1.082
150	1.06	2.637	1.006	3.652	0.382	1.647	1.138
180	1.42	2.817	0.971	3.737	0.345	1.726	1.216
210	1.78	2.918	0.986	3.878	0.338	1.736	1.259
240	2.17	3.017	0.922	3.799	0.306	1.825	1.302
300	2.53	3.079	0.877	3.743	0.286	1.885	1.329
360	2.89	3.102	0.866	3.736	0.280	1.902	1.339
420	3.25	3.143	0.850	3.733	0.271	1.928	1.357
480	3.95	3.170	0.779	3.596	0.246	2.006	1.368
540	4.72	3.156	0.733	3.491	0.233	2.048	1.362
600	5.44	3.133	0.681	3.375	0.218	2.095	1.352
720	6.23	3.106	0.656	3.311	0.212	2.113	1.341
840	7.03	3.098	0.600	3.213	0.194	2.167	1.337
960	7.82	3.089	0.596	3.200	0.194	2.169	1.333
080	9.36	3.047	0.557	3.112	0.183	2.197	1.315
200	10.90	2.991	0.578	3.103	0.194	2.162	1.291
320	12.34	2.966	0.510	2.991	0.172	2.224	1.280
440	13.91	2.918	0.510	2.958	0.175	2.213	1.260
525	15.00	2.871	0.512	2.929	0.179	2.199	1.239

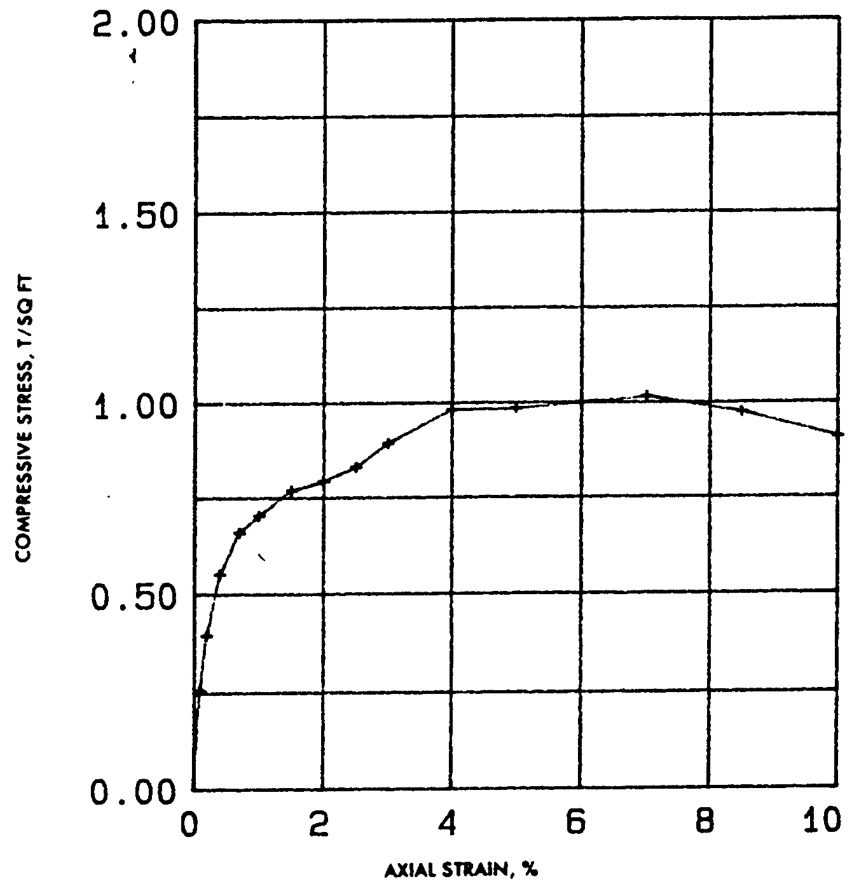
Table 3 - Triaxial $\bar{R}$ Test Results

Project : CHASKA; CENCS-IA-90-78-ED-GH
Boring Number : 90-139 MU
Sample Number : S-3
Depth : 31'-33'
Confining Pressure : 4 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.10	1.090	0.377	1.301	0.347	3.893	0.470
30	0.19	2.006	0.821	1.631	0.410	3.676	0.866
45	0.39	2.600	1.224	1.937	0.471	3.420	1.122
60	0.53	3.087	1.518	2.244	0.492	3.246	1.332
90	0.72	3.431	1.777	2.543	0.519	3.072	1.481
120	0.89	3.651	1.896	2.735	0.520	3.008	1.576
150	1.06	3.801	1.961	2.864	0.517	2.980	1.640
180	1.42	3.888	1.939	2.887	0.499	3.024	1.678
210	1.79	3.974	1.931	2.921	0.486	3.053	1.715
240	2.17	4.094	1.948	2.995	0.476	3.066	1.767
300	2.53	4.144	1.988	3.059	0.480	3.038	1.789
360	2.90	4.160	1.948	3.027	0.469	3.082	1.795
420	3.26	4.226	1.935	3.047	0.458	3.111	1.824
480	3.96	4.325	1.970	3.131	0.456	3.101	1.867
540	4.73	4.417	1.882	3.086	0.427	3.212	1.907
600	5.45	4.511	1.821	3.070	0.404	3.296	1.947
720	6.25	4.598	1.777	3.068	0.387	3.361	1.984
840	7.05	4.666	1.716	3.043	0.368	3.439	2.014
960	7.84	4.716	1.637	2.996	0.348	3.531	2.036
1080	9.39	4.782	1.479	2.897	0.310	3.705	2.064
1200	10.93	4.796	1.373	2.826	0.287	3.814	2.070
1320	12.38	4.797	1.281	2.764	0.268	3.907	2.070
1440	13.95	4.786	1.242	2.735	0.260	3.943	2.066
1521	15.00	4.707	1.206	2.685	0.257	3.959	2.032

FAILURE SKETCHES





☐ CONTROLLED STRESS

☒ CONTROLLED STRAIN

TEST NO.						
TYPE OF SPECIMEN UNDISTURBED						
INITIAL	WATER CONTENT	w_o	27.6 %	%	%	%
	VOID RATIO	e_o	0.75			
	SATURATION	S_o	100 %	%	%	%
	DRY DENSITY, LB/CU FT	γ_d	96.9			
TIME TO FAILURE, MIN		t_f	14.5			
UNCONFINED COMPRESSIVE STRENGTH, T/SQ FT		q_u	1.01			
UNDRAINED SHEAR STRENGTH, T/SQ FT		s_u	0.51			
SENSITIVITY RATIO		S_t				
INITIAL SPECIMEN DIAMETER, IN		D_o	1.41			
INITIAL SPECIMEN HEIGHT, IN.		H_o	2.99			

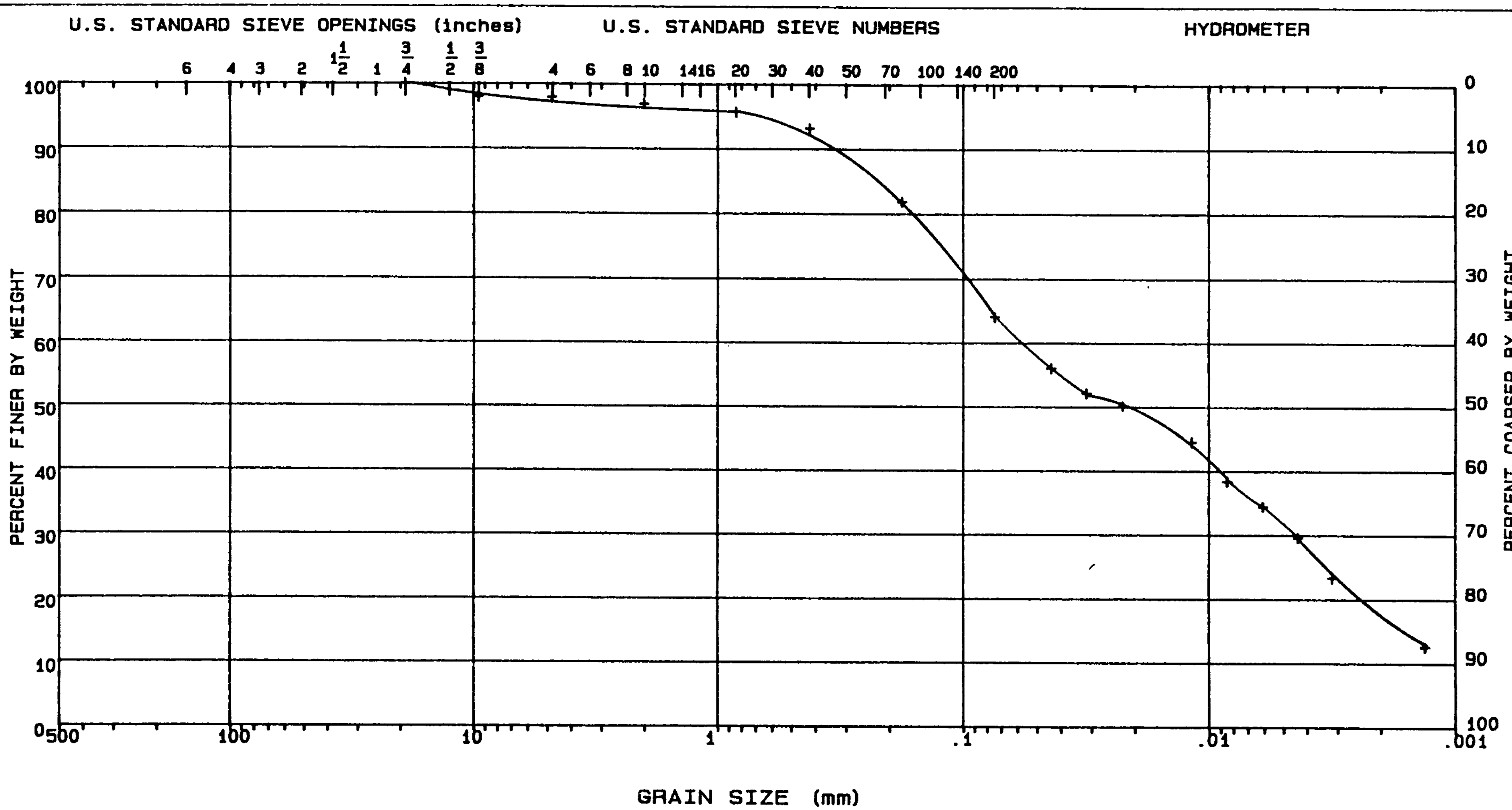
CLASSIFICATION Lean clay, CL

LL	PL	PI	G_s
44	20	24	2.71

REMARKS Gray brown. Torvane=1.25TSF. Highly calcareous.

PROJECT	CHASKA; CENCS-IA-90-78-ED-6H		
AREA	MRD LAB NO. : 90/358		
BORING NO.	90-139 MU	SAMPLE NO.	S-3
DEPTH EL	31'-33'	DATE	09-20-90

UNCONFINED COMPRESSION TEST REPORT



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

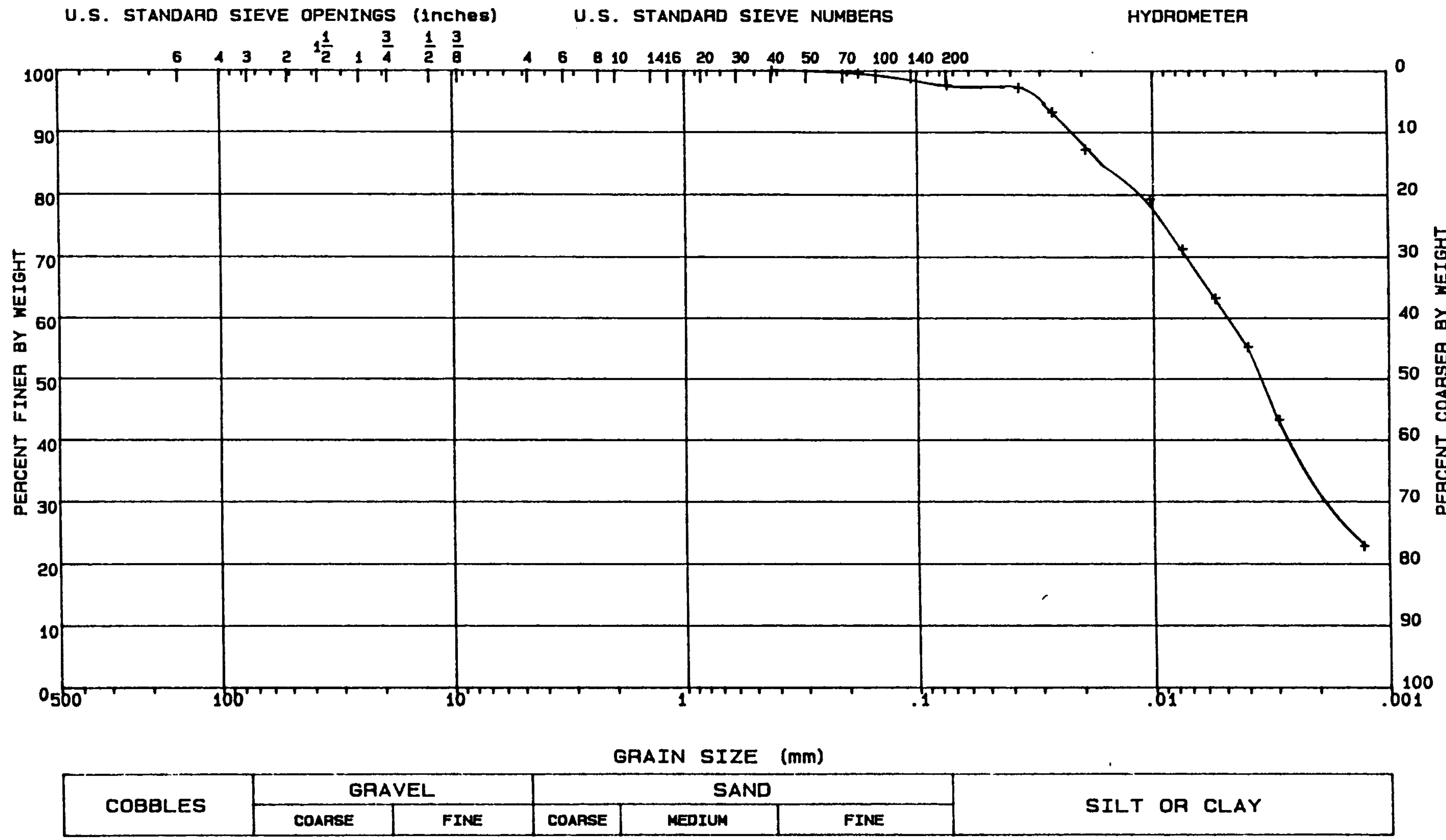
LL = 21	PL = 16	PI = 5	Gs = 2.69	NAT w = %

CLASSIFICATION Sandy silt, CL-ML

GRADATION CURVE

PROJECT	CHASKA; CENCS-IA-90-78-ED-GH
DATE	09-19-90
BORING NO.	90-139 MU
SAMPLE NO.	S-3 (TOP)
DEPTH/ELEV	31'-33'
MRD LAB NO.	90/358

FIGURE 8



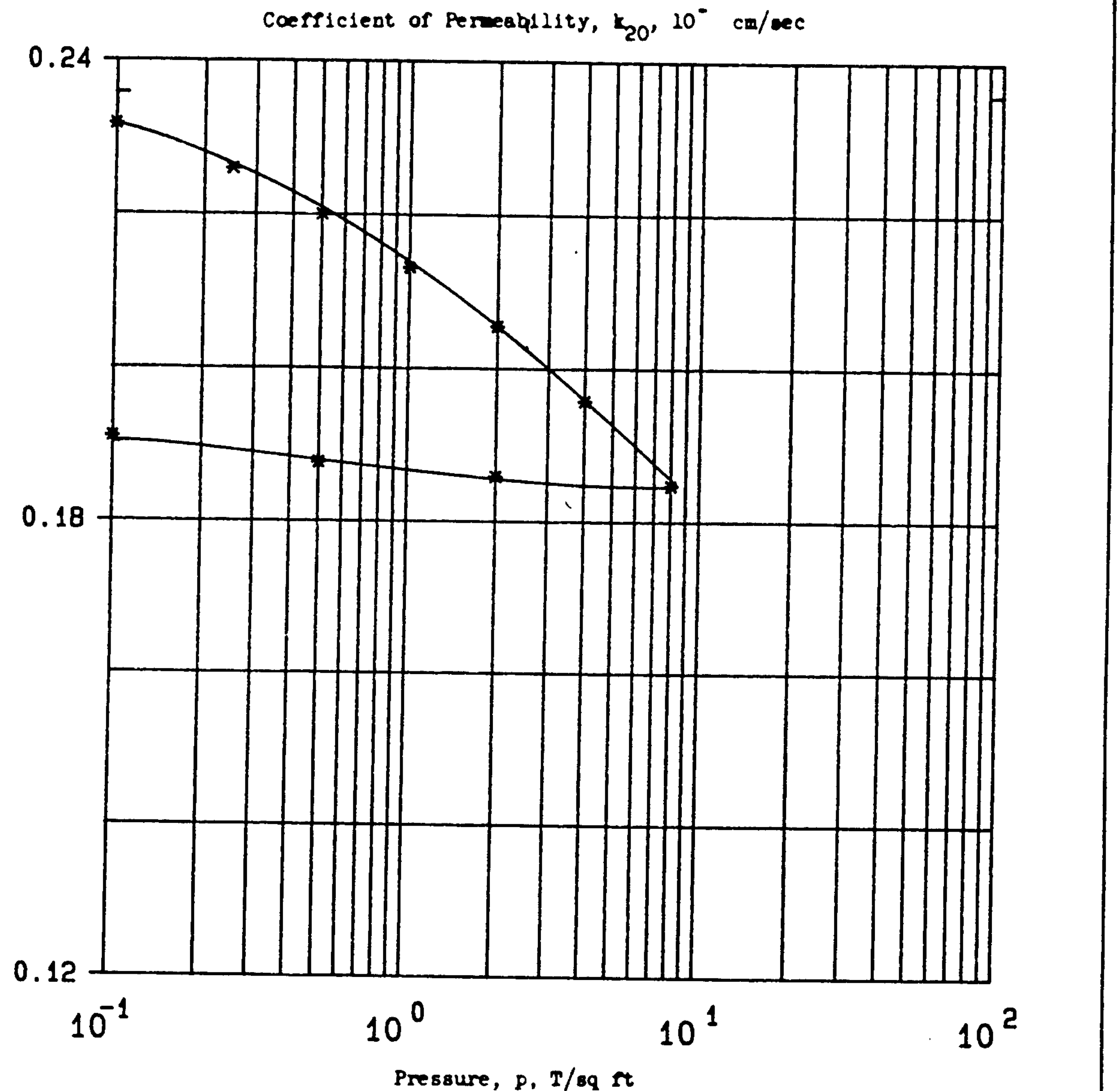
LL = 44	PL = 20	PI = 24	Gs = 2.71	NAT w = %

CLASSIFICATION Lean clay, CL

PROJECT	CHASKA; CENCS-IA-90-78-ED-GH
DATE	09-24-90
BORING NO.	90-139 MU
SAMPLE NO.	S-3 (BOT.)
DEPTH/ELEV	31'-33'
MRD LAB NO.	90/358

GRADATION CURVE

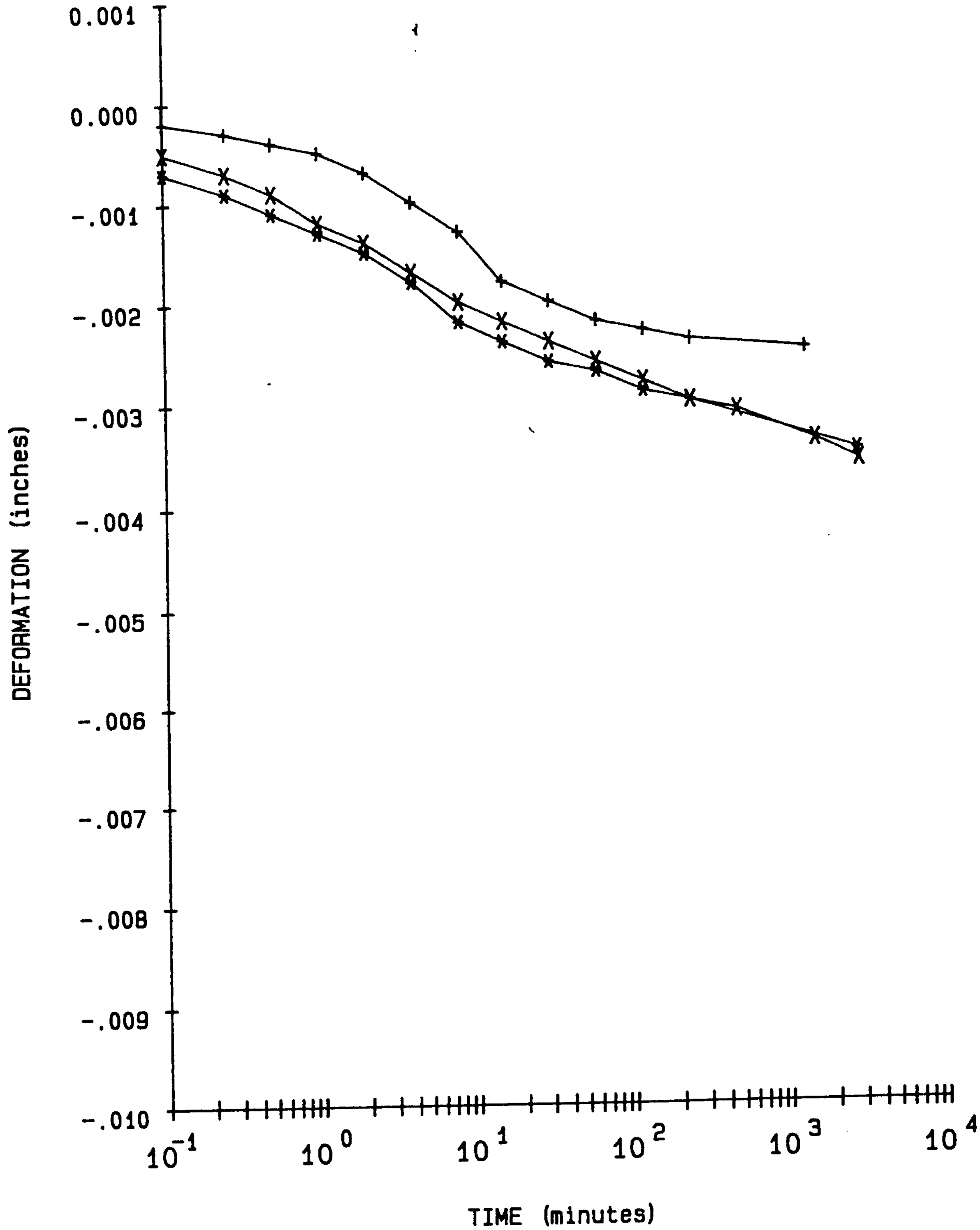
FIGURE 9



Type of Specimen UNDISTURBED		Before Test		After Test	
Diam 2.5 in.	Ht .75 in.	Water Content, w_o	8.9 %	w_f	8.9 %
Overburden Pressure, p_o T/sq ft		Void Ratio, e_o	0.24	e_f	0.19
Preconsol. Pressure, p_c T/sq ft		Saturation, S_o	99 %	S_f	100 %
Compression Index, C_c		Dry Density, γ_d	132.8 lb/ft^3		
Classification Silty sand, ~~CL-ML~~ SC-SM		k_{20} at e_o = × 10⁻ cm/sec			
LL 17	G_s 2.63	Project CHASKA; CENCS-IA-90-78-ED-GH			
PL 11	D_{10}				
Remarks Gray Brown. Slightly		Area MRD LAB NO. 90/358			
organic, slightly calcareous.		Boring No. 90-139 MU		Sample No. S-4	
		Depth El 44'-46'		Date 10-12-90	
		CONSOLIDATION TEST REPORT			

ENG FORM 1 MAY 63 2090 PREVIOUS EDITIONS ARE OBSOLETE.

Figure 10



LEGEND

+ = .1 TSF Wet

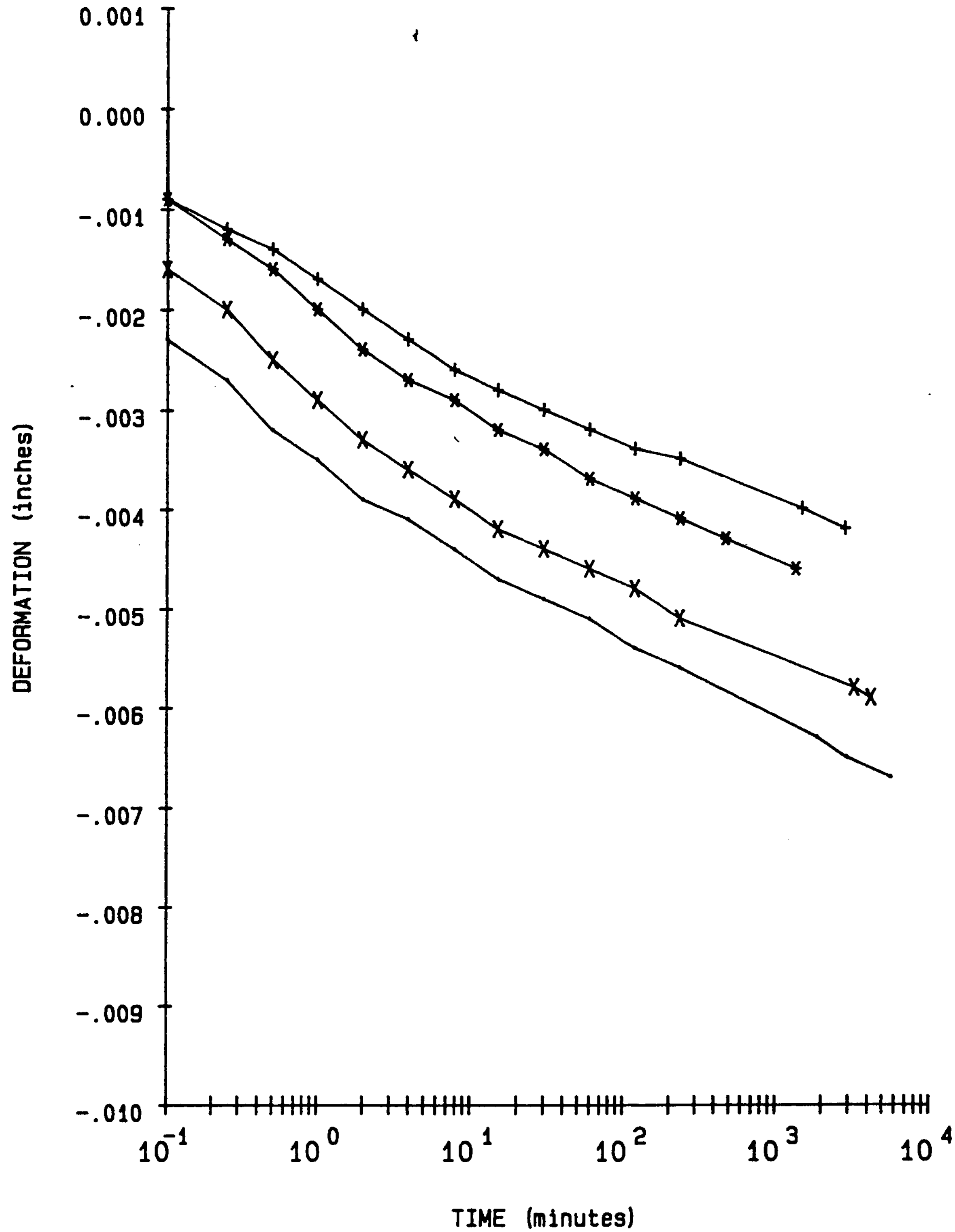
✱ = .25 TSF

X = .5 TSF

PROJECT	CHASKA: CENCS-IA-90-78-ED-GH
BORING NO.	90-139 MU
SAMPLE NO.	S-4
DEPTH/ELEV	44'-46'
MRD LAB NO.	90/358

FIGURE 11

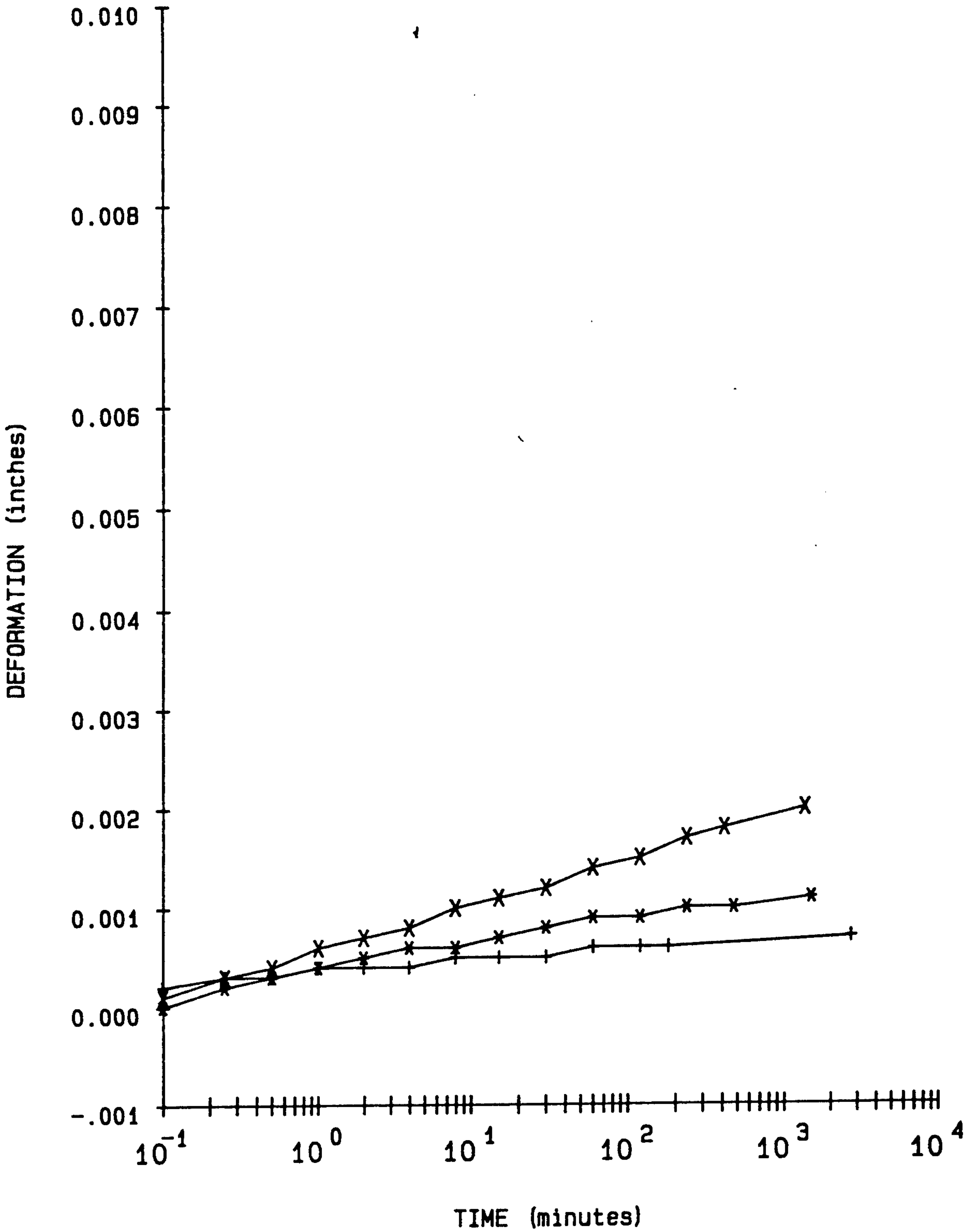
FIGURE D-150



LEGEND	
+ = 1	TSF
* = 2	TSF
X = 4	TSF
- = 8	TSF

PROJECT	CHASKA; CENCS-IA-90-78-ED-GH
BORING NO.	90-139 MU
SAMPLE NO.	S-4
DEPTH/ELEV	44'-46'
MRD LAB NO.	90/358

FIGURE 12



LEGEND		
+ = 2	TSF	Rebound
✱ = .5	TSF	Rebound
X = .1	TSF	Rebound

PROJECT	CHASKA: CENCS-IA-90-78-ED-GH
BORING NO.	90-139 MU
SAMPLE NO.	S-4
DEPTH/ELEV	44'-46'
MRD LAB NO.	90/358

FIGURE 13

Consolidation Test Data

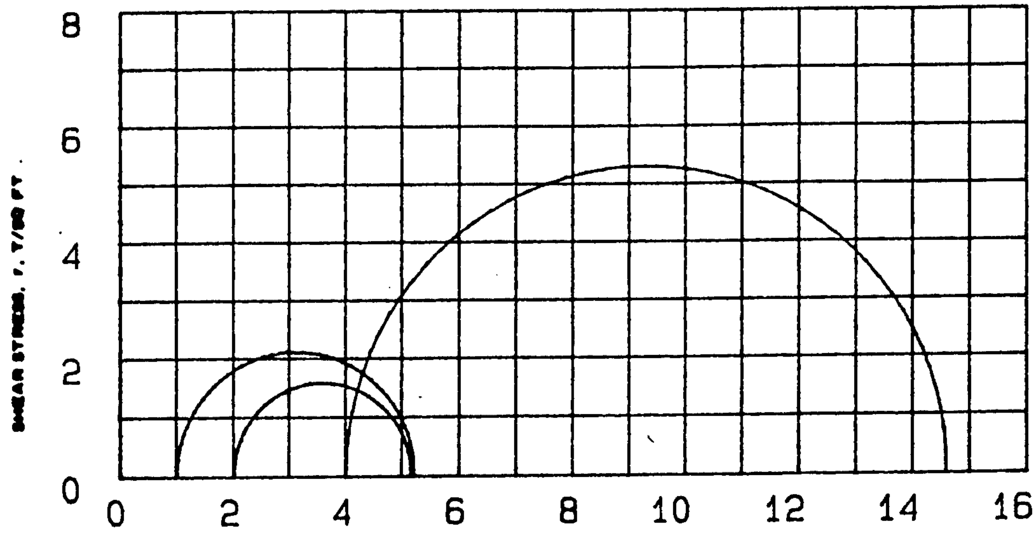
Project CHASKA; CENCS-IA-90-78-ED-GH

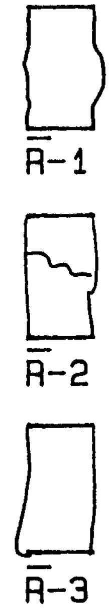
Boring No. 90-139 MU
Sample No. S-4
Depth/Elev 44'-46'
MRD Lab No. 90/358

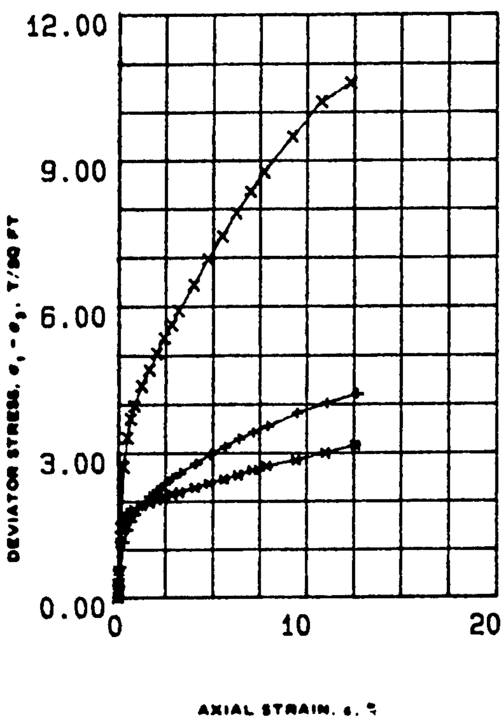
Gs = 2.63
eo = 0.236
0.42eo = 0.099

Water Content (%)	Dry Weight (gms)	Dry Density (PCF)	Void Ratio	Pressure (TSF)	Saturation (%)
8.9	128.4	132.8	0.236		99.1
8.9	128.4	133.2	0.232	0.10	100.0
8.9	128.4	133.9	0.226	0.25	100.0
8.9	128.4	134.5	0.220	0.50	100.0
8.9	128.4	135.3	0.213	1.00	100.0
8.9	128.4	136.1	0.205	2.00	100.0
8.9	128.4	137.2	0.196	4.00	100.0
8.9	128.4	138.5	0.185	8.00	100.0
8.9	128.4	138.4	0.186	2.00	100.0
8.9	128.4	138.2	0.188	0.50	100.0
8.9	128.4	137.8	0.191	0.10	100.0

Axial Strain (%)	Void Ratio
1	0.223
2	0.211
3	0.199
4	0.186
5	0.174
6	0.162
7	0.149







		SPECIMEN NO.	1 (+)	2 (*)	3 (X)	
INITIAL	WATER CONTENT, %	w_o	9.60	12.1	10.9	
	DRY DENSITY LB/CU FT	γ_{d_o}	121.9	125	128.5	
	SATURATION, %	S_o	72	100	100	
	VOID RATIO	e_o	.35	.31	.28	
BEFORE SHEAR	WATER CONTENT, %	w_c	9.7	10	11.5	
	DRY DENSITY LB/CU FT	γ_{d_c}	133.7	133.4	131	
	SATURATION, %	S_c	100	100	100	
	VOID RATIO	e_c	.23	.23	.25	
	FINAL BACK PRESSURE, T/SQ FT	u_o	4.103	4.103	4.103	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1	2	4	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	4.218	3.161	10.598	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	1320	1320	1320	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	4.218	3.161	10.598	
INITIAL DIAMETER, IN.		D_o	1.4	1.39	1.4	
INITIAL HEIGHT, IN.		H_o	2.98	2.98	3	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Silty sand, ~~CL-ML~~ SC-SM B-Value 1.0 1.0 1.0

LL 17	PL 11	PI 6	G_s 2.63	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST RBAR

REMARKS: Gray brown. Slightly organic slightly calcareous. Specimens required extensive patchwork.

PROJECT CHASKA; CENCS-IA-90-78-ED-GH

BORING NO 90-139 MU SAMPLE NO. S-4

DEPTH ELEV 44'-46'

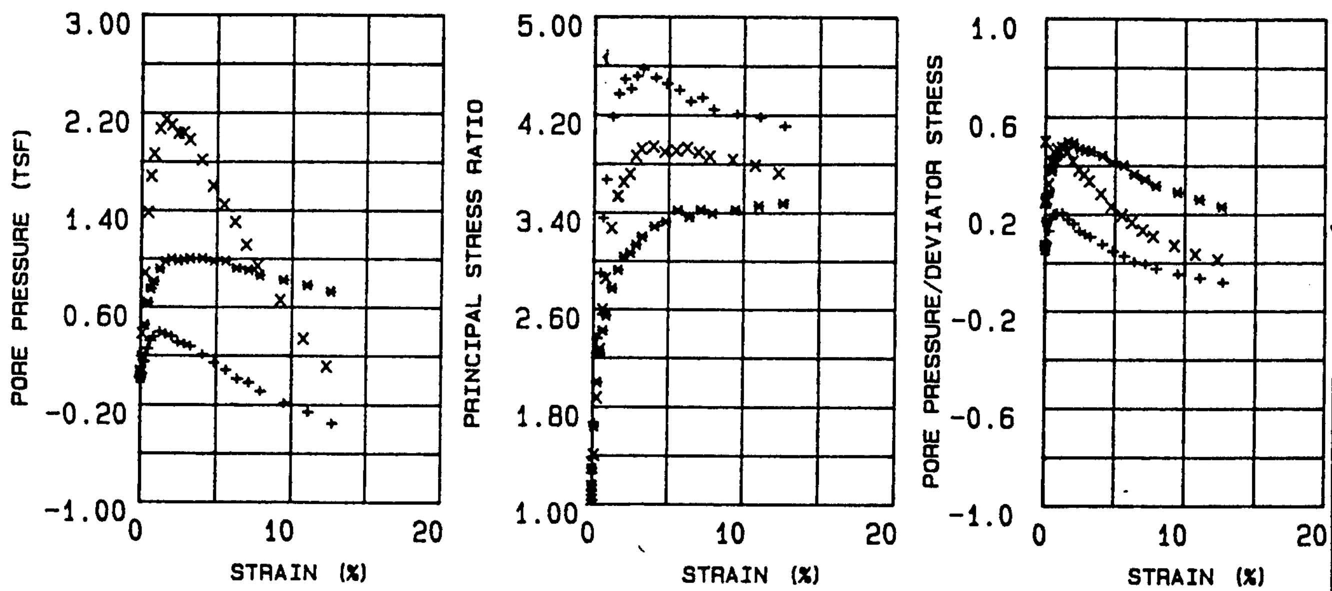
LABORATORY 90/358 DATE 09-27-90

TRIAXIAL COMPRESSION TEST REPORT

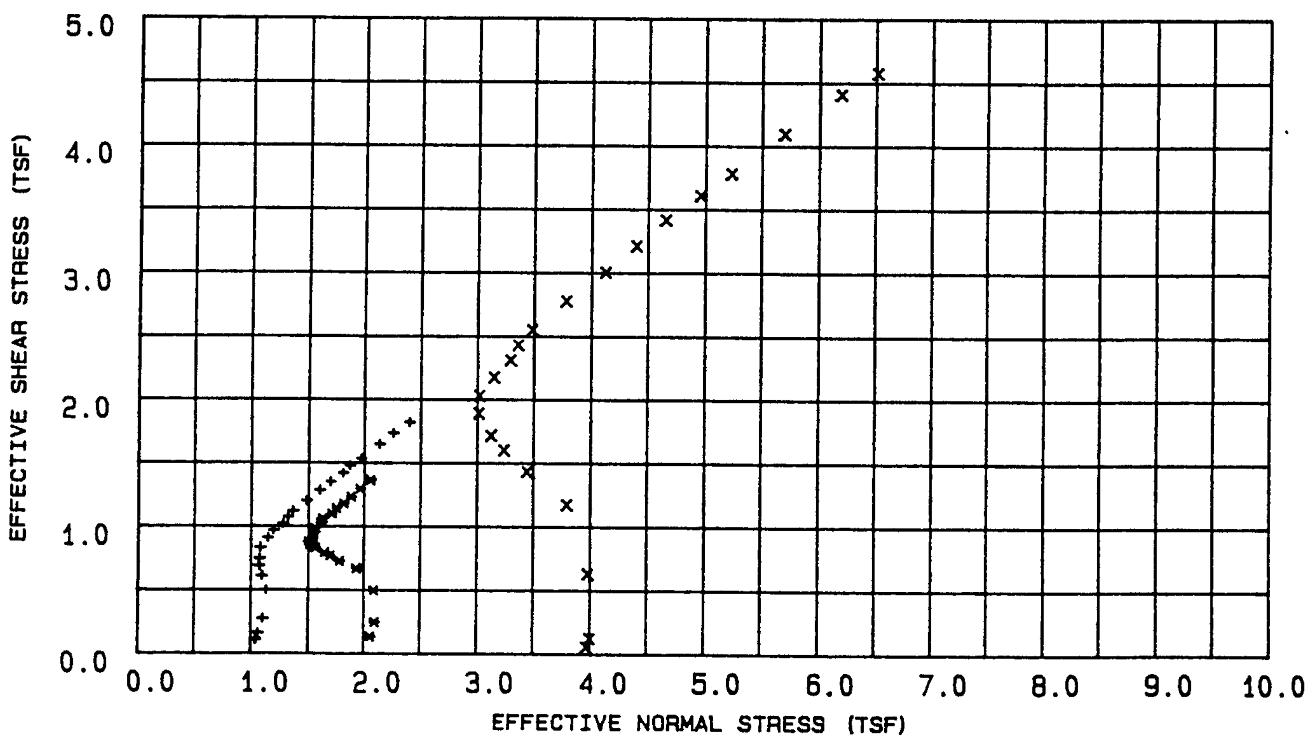
ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

FIGURE 14

15



EFFECTIVE STRESS VECTOR CURVES ON 60 DEGREE PLANE



LEGEND

+ = 1 TSF

* = 2 TSF

X = 4 TSF

PROJECT	CHASKA: CENCS-IA-90-78-ED-GH
BORING NO.	90-139 MU
SAMPLE NO.	S-4
DEPTH/ELEV	44'-46'
MRD LAB NO.	90/358

FIGURE 5

Table 4 - Triaxial $\bar{R}$ Test Results

Project : CHASKA; CENCS-IA-90-78-ED-GH
Boring Number : 90-139 MU
Sample Number : S-4
Depth : 44'-46'
Confining Pressure : 1 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.02	0.249	0.017	1.254	0.070	1.045	0.108
30	0.02	0.371	0.027	1.382	0.074	1.065	0.160
45	0.12	0.633	0.052	1.668	0.082	1.105	0.273
60	0.30	1.156	0.151	2.361	0.131	1.135	0.499
90	0.50	1.413	0.255	2.898	0.181	1.095	0.610
120	0.67	1.596	0.322	3.355	0.202	1.073	0.689
150	0.87	1.731	0.352	3.670	0.204	1.076	0.747
180	1.27	1.924	0.395	4.183	0.206	1.081	0.831
210	1.67	2.107	0.375	4.371	0.179	1.147	0.909
240	2.07	2.242	0.358	4.491	0.160	1.197	0.968
300	2.49	2.366	0.306	4.410	0.130	1.280	1.021
360	2.89	2.489	0.292	4.516	0.118	1.324	1.074
420	3.29	2.594	0.275	4.576	0.106	1.367	1.120
480	4.11	2.780	0.206	4.501	0.075	1.482	1.200
540	4.86	2.975	0.139	4.455	0.047	1.598	1.284
600	5.66	3.129	0.080	4.402	0.026	1.695	1.351
720	6.41	3.291	0.006	4.311	0.002	1.809	1.420
840	7.18	3.422	-0.024	4.341	-0.007	1.871	1.477
960	7.95	3.551	-0.094	4.245	-0.026	1.973	1.533
1080	9.52	3.816	-0.191	4.205	-0.049	2.136	1.647
1200	11.09	4.019	-0.264	4.180	-0.065	2.259	1.734
1320	12.69	4.218	-0.358	4.107	-0.084	2.402	1.821

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Table 5 - Triaxial $\bar{R}$ Test Results

Project : CHASKA; CENCS-IA-90-78-ED-GH
Boring Number : 90-139 MU
Sample Number : S-4
Depth : 44'-46'
Confining Pressure : 2 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.02	0.309	0.016	1.156	0.053	2.061	0.134
30	0.02	0.571	0.043	1.292	0.075	2.098	0.246
45	0.12	1.152	0.195	1.638	0.170	2.090	0.497
60	0.30	1.549	0.451	2.000	0.291	1.933	0.669
90	0.49	1.684	0.637	2.236	0.379	1.780	0.727
120	0.67	1.779	0.750	2.424	0.422	1.691	0.768
150	0.87	1.834	0.812	2.544	0.443	1.642	0.791
180	1.26	1.922	0.915	2.771	0.476	1.561	0.830
210	1.66	1.970	0.978	2.927	0.497	1.510	0.850
240	2.05	2.037	1.000	3.037	0.491	1.504	0.879
300	2.47	2.103	0.982	3.066	0.468	1.539	0.907
360	2.87	2.149	0.993	3.133	0.462	1.539	0.927
420	3.26	2.195	1.003	3.201	0.457	1.540	0.947
480	4.08	2.284	1.001	3.287	0.439	1.564	0.986
540	4.82	2.374	0.979	3.326	0.413	1.609	1.025
600	5.61	2.460	0.982	3.418	0.400	1.627	1.062
720	6.36	2.547	0.922	3.363	0.363	1.708	1.099
840	7.12	2.649	0.906	3.421	0.342	1.750	1.143
960	7.89	2.731	0.859	3.393	0.315	1.817	1.179
1080	9.45	2.851	0.822	3.421	0.289	1.884	1.231
1200	11.01	3.002	0.778	3.457	0.260	1.965	1.296
1320	12.59	3.161	0.724	3.477	0.229	2.059	1.364

Table 6 - Triaxial $\bar{R}$ Test Results

Project : CHASKA; CENCS-IA-90-78-ED-GH
Boring Number : 90-139 MU
Sample Number : S-4
Depth : 44'-46'
Confining Pressure : 4 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.02	0.122	0.061	1.031	0.499	3.969	0.053
30	0.02	0.278	0.069	1.071	0.248	4.000	0.120
45	0.12	1.457	0.381	1.403	0.262	3.980	0.629
60	0.29	2.717	0.879	1.871	0.324	3.794	1.173
90	0.48	3.315	1.382	2.266	0.417	3.439	1.431
120	0.65	3.705	1.678	2.595	0.453	3.239	1.599
150	0.85	3.971	1.860	2.856	0.469	3.123	1.714
180	1.23	4.381	2.071	3.271	0.473	3.014	1.891
210	1.62	4.702	2.144	3.533	0.456	3.020	2.029
240	2.01	5.038	2.099	3.650	0.417	3.148	2.174
300	2.42	5.352	2.030	3.717	0.380	3.295	2.310
360	2.81	5.631	2.034	3.865	0.362	3.360	2.430
420	3.19	5.907	1.978	3.921	0.335	3.484	2.550
480	3.99	6.435	1.811	3.940	0.282	3.782	2.777
540	4.72	6.958	1.597	3.895	0.230	4.126	3.003
600	5.49	7.436	1.443	3.908	0.195	4.398	3.210
720	6.22	7.910	1.301	3.930	0.165	4.657	3.414
840	6.97	8.356	1.110	3.892	0.133	4.959	3.607
960	7.71	8.763	0.936	3.860	0.107	5.234	3.782
.080	9.24	9.486	0.652	3.834	0.069	5.697	4.094
.200	10.76	10.211	0.336	3.787	0.033	6.192	4.407
.320	12.31	10.598	0.109	3.724	0.011	6.515	4.574

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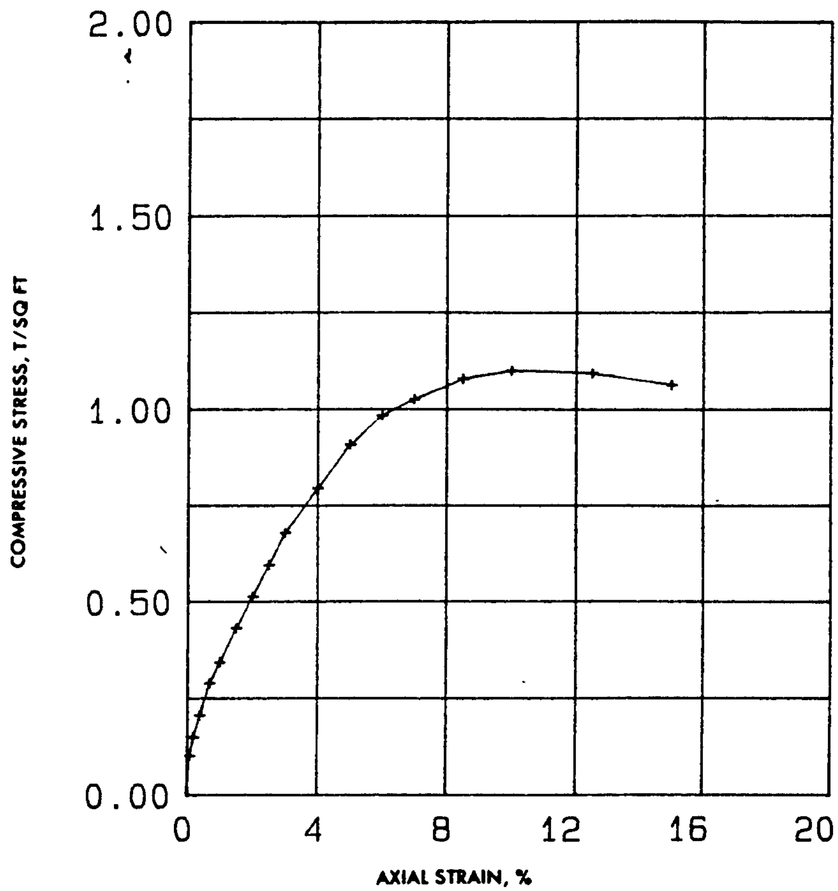
FAILURE SKETCHES



☐ CONTROLLED STRESS

☒ CONTROLLED STRAIN

TEST NO.						
TYPE OF SPECIMEN UNDISTURBED						
INITIAL	WATER CONTENT	w_o	12.3 %	%	%	%
INITIAL	VOID RATIO	e_o	0.32			
INITIAL	SATURATION	S_o	100 %	%	%	%
INITIAL	DRY DENSITY, LB/CU FT	γ_d	124.6			
TIME TO FAILURE, MIN		t_f	21.5			
UNCONFINED COMPRESSIVE STRENGTH, T/SQ FT		q_u	1.10			
UNDRAINED SHEAR STRENGTH, T/SQ FT		s_u	0.55			
SENSITIVITY RATIO		S_t				
INITIAL SPECIMEN DIAMETER, IN		D_o	1.39			
INITIAL SPECIMEN HEIGHT, IN.		H_o	2.99			

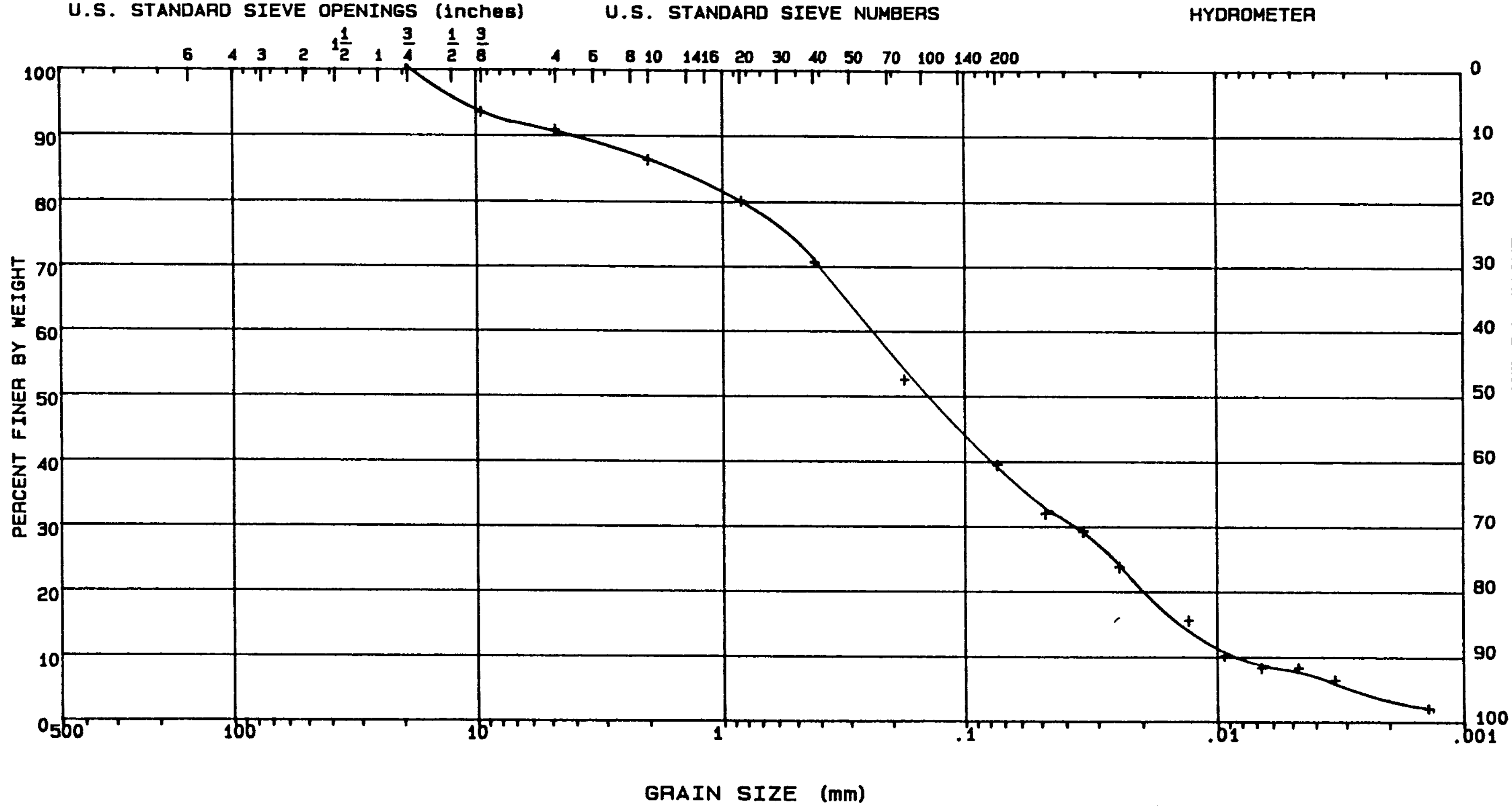
CLASSIFICATION Silty sand, ~~CL-ML~~ SC-SM

LL 17	PL 11	PI 6	G_s 2.63

REMARKS Gray brown. Slightly organic, slightly calcareous.

PROJECT	CHASKA; CENCS-IA-90-78-ED-GH		
AREA	MRD LAB NO. : 90/358		
BORING NO.	90-139 MU	SAMPLE NO.	S-4
DEPTH EL	44'-46'	DATE	09-26-90

UNCONFINED COMPRESSION TEST REPORT



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

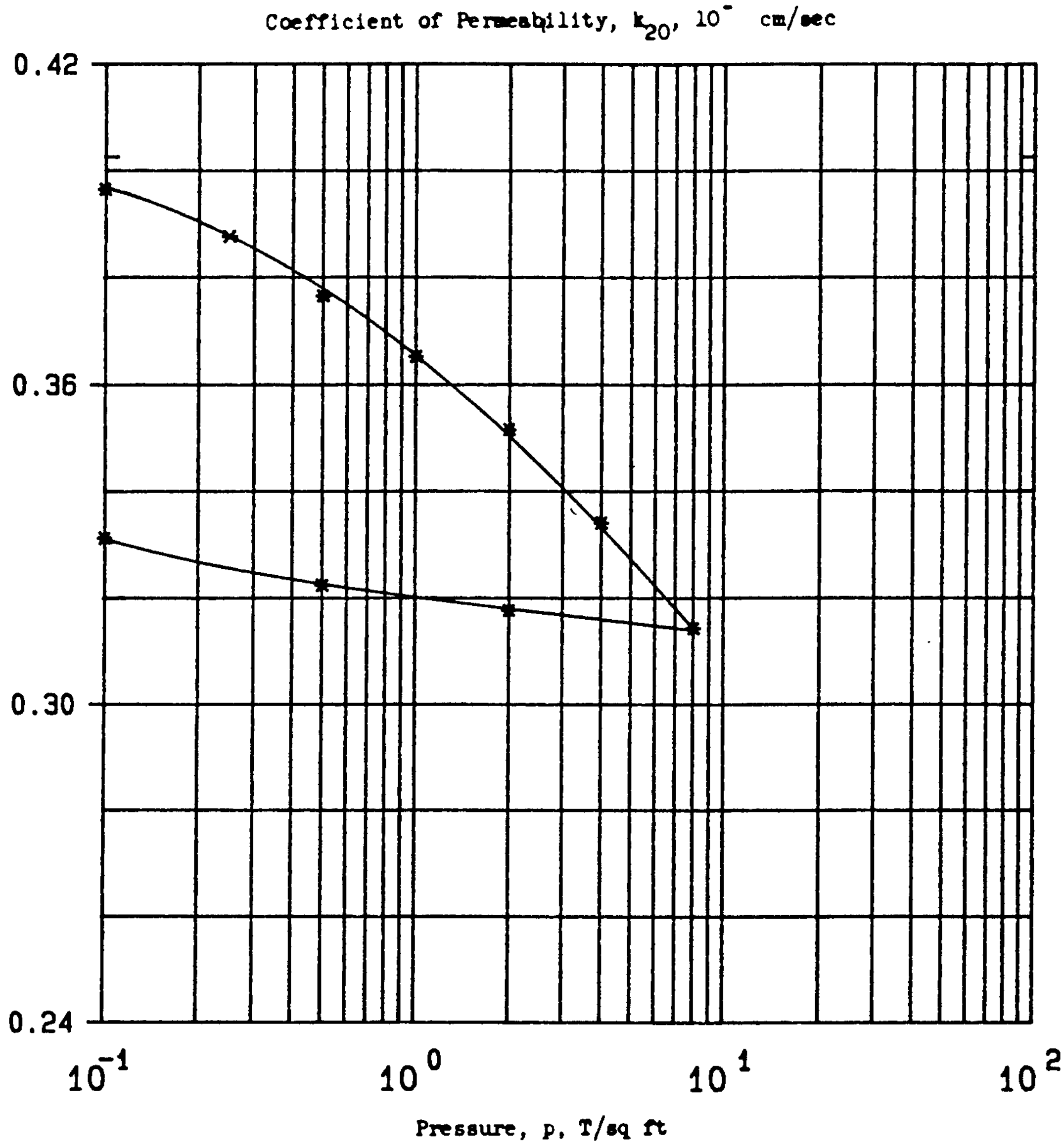
LL = 17	PL = 11	PI = 6	Gs = 2.63	NAT w = %

CLASSIFICATION Silty sand, ~~CL-ML~~ SC-SM

PROJECT	CHASKA; CENCS-IA-90-78-ED-GH
DATE	09-26-90
BORING NO.	90-139 MU
SAMPLE NO.	S-4
DEPTH/ELEV	44'-46'
MRD LAB NO.	90/358

GRADATION CURVE

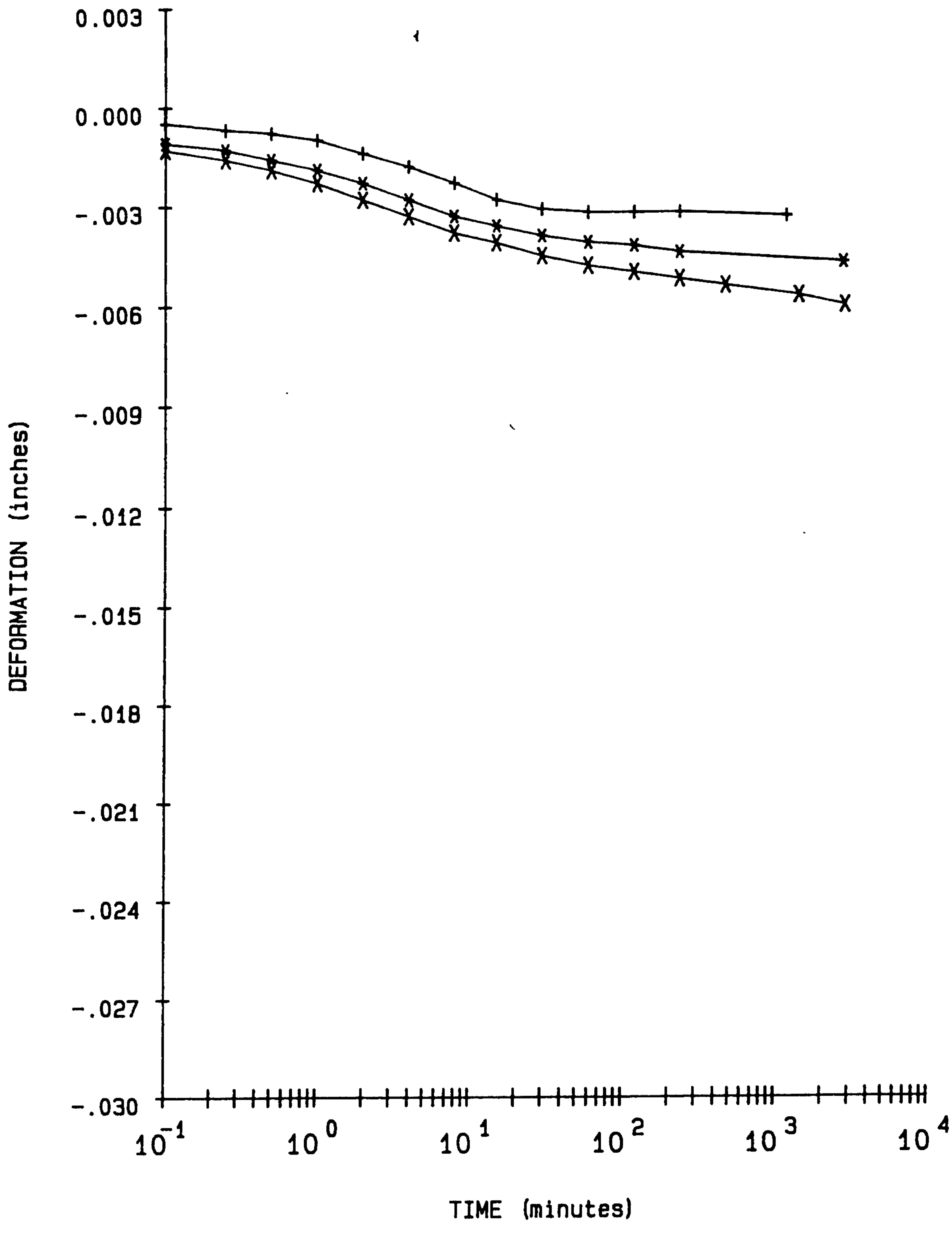
FIGURE 17



Type of Specimen UNDISTURBED		Before Test	After Test
Diam 2.5 in.	Ht .75 in.	Water Content, w_o 12.9 %	w_f 11.7 %
Overburden Pressure, p_o T/sq ft		Void Ratio, e_o 0.40	e_f 0.33
Preconsol. Pressure, p_c T/sq ft		Saturation, S_o 87 %	S_f 95 %
Compression Index, C_c		Dry Density, γ_d 120.6 lb/ft^3	—
Classification Sandy clay, CL		k_{20} at e_o = × 10^{-} cm/sec	
LL 21	G_s 2.71	Project CHASKA: CENCS-IA-90-78-ED-GH	
PL 12	D_{10} 9		
Remarks Gray brown. Torvane=0.56 TSF. Slightly organic, slightly calcareous. Material becomes more sandy toward the top.		Area MRD LAB NO. 90/358	
		Boring No. 90-139 MU	Sample No. S-5
		Depth El 54'-56'	Date 10-12-90
		CONSOLIDATION TEST REPORT	

ENG FORM 1 MAY 63 2090 PREVIOUS EDITIONS ARE OBSOLETE.

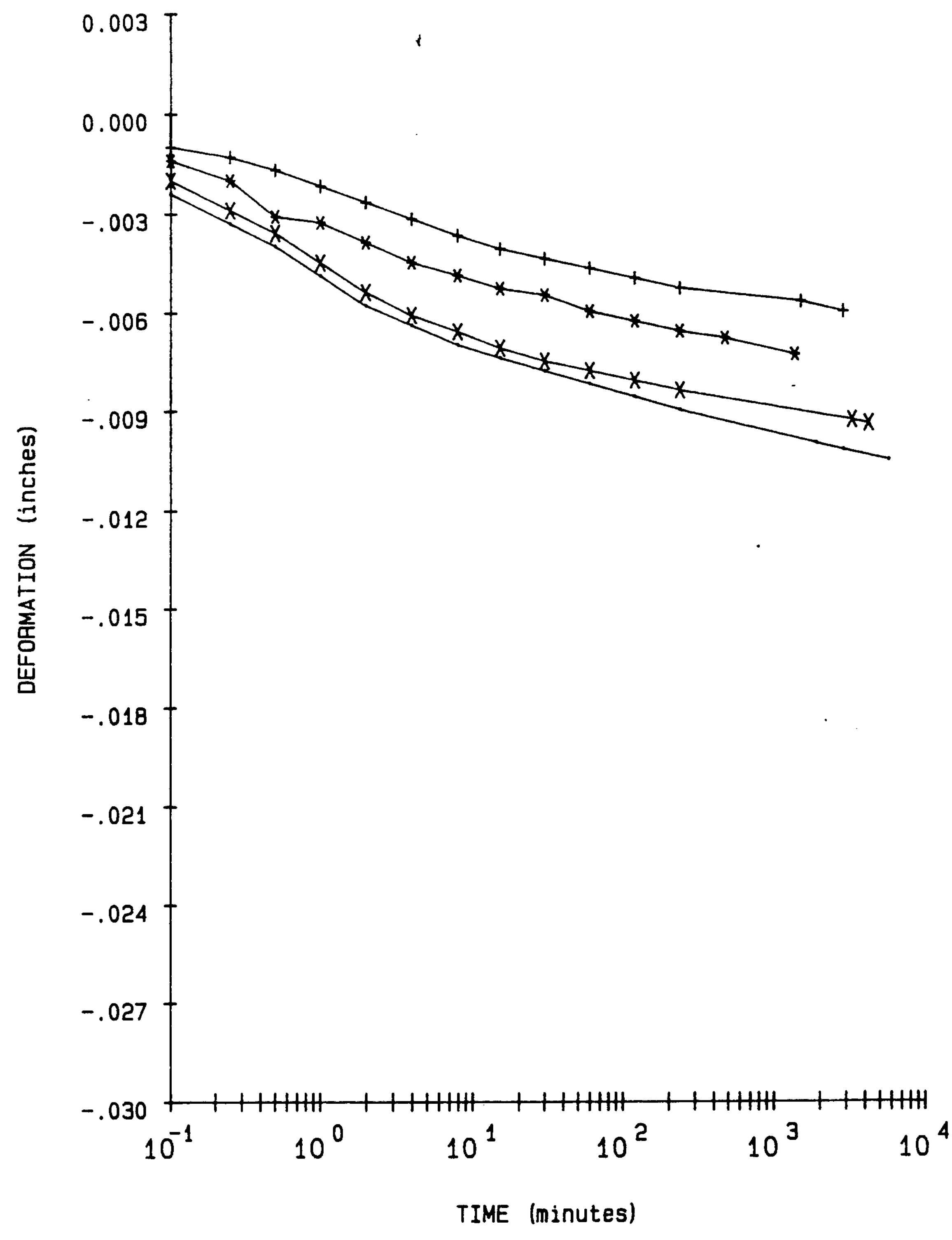
Figure 18



LEGEND	
+ = .1 TSF Wet	
* = .25 TSF	
X = .5 TSF	

PROJECT	CHASKA: CENCS-IA-90-78-ED-GH
BORING NO.	90-139 MU
SAMPLE NO.	S-5
DEPTH/ELEV	54'-56'
MRD LAB NO.	90/358

FIGURE Figure 19

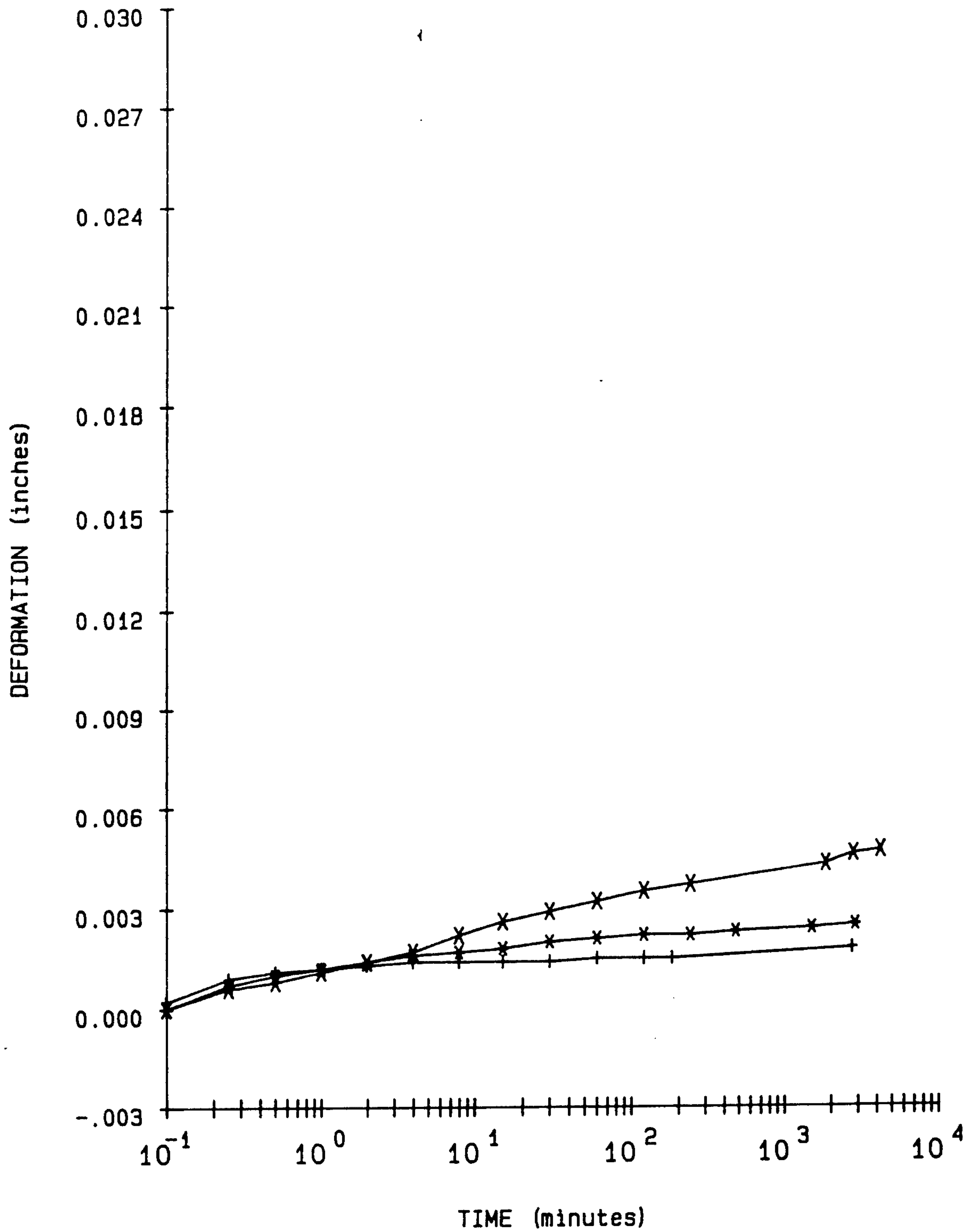


LEGEND	
+ = 1	TSF
* = 2	TSF
X = 4	TSF
- = 8	TSF

PROJECT	CHASKA; CENCS-IA-90-78-ED-GH
BORING NO.	90-139 MU
SAMPLE NO.	S-5
DEPTH/ELEV	54'-56'
MRD LAB NO.	90/358

FIGURE 20

FIGURE D-163



LEGEND

+ = 2 TSF Rebound

* = .5 TSF Rebound

X = .1 TSF Rebound

PROJECT	CHASKA: CENCS-IA-90-78-ED-GH
BORING NO.	90-139 MU
SAMPLE NO.	S-5
DEPTH/ELEV	54'-56'
MRD LAB NO.	90/358

FIGURE 21

FIGURE D-164

Consolidation Test Data

Project CHASKA; CENCS-IA-90-78-ED-GH

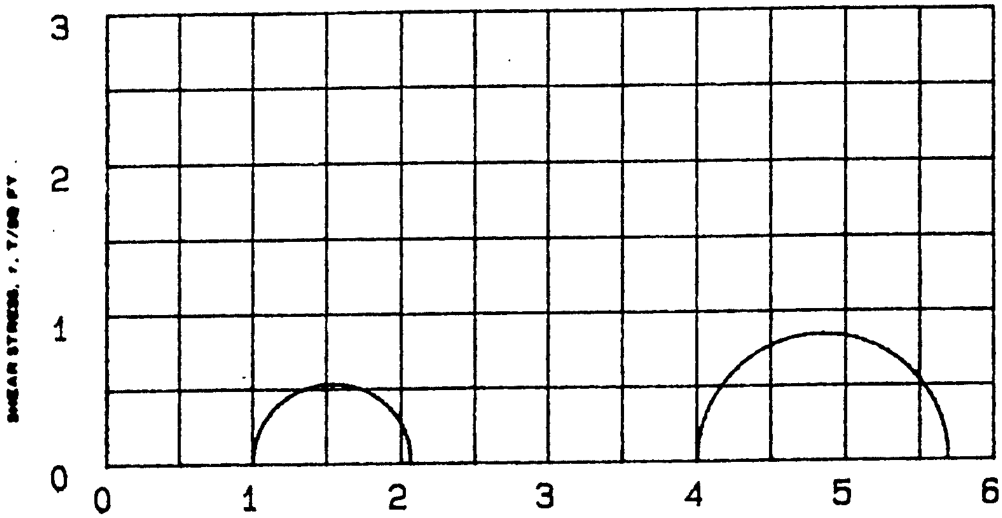
Boring No. 90-139 MU
Sample No. S-5
Depth/Elev 54'-56'
MRD Lab No. 90/358

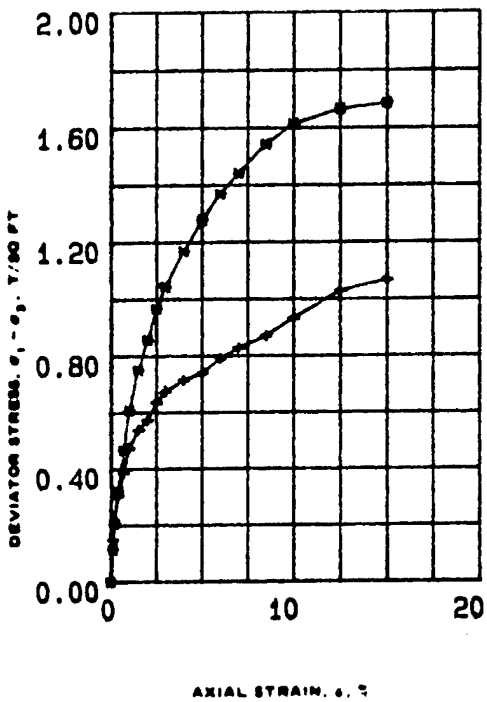
Gs = 2.71
eo = 0.403
0.42eo = 0.169

Water Content (%)	Dry Weight (gms)	Dry Density (PCF)	Void Ratio	Pressure (TSF)	Saturation (%)
12.9	116.0	120.6	0.403		87.1
11.7	116.0	121.1	0.396	0.10	79.6
11.7	116.0	121.9	0.388	0.25	81.4
11.7	116.0	122.9	0.376	0.50	83.9
11.7	116.0	123.9	0.365	1.00	86.5
11.7	116.0	125.1	0.352	2.00	89.8
11.7	116.0	126.8	0.334	4.00	94.5
11.7	116.0	128.7	0.314	8.00	100.0
11.7	116.0	128.3	0.318	2.00	99.4
11.7	116.0	127.9	0.322	0.50	97.9
11.7	116.0	127.0	0.331	0.10	95.3

Axial Strain (%)	Void Ratio
1	0.389
2	0.375
3	0.361
4	0.346
5	0.332
6	0.318
7	0.304
8	0.290
9	0.276

FIGURE D-165





SPECIMEN NO.			1 (+)	2 (✱)
INITIAL	WATER CONTENT, %	w_o	12.4	12.7
	DRY DENSITY LB/CU FT	γd_o	123.4	121.6
	SATURATION, %	S_o	91.0	88.0
	VOID RATIO	e_o	0.37	0.39
BEFORE SHEAR	WATER CONTENT, %	w_c	12.6	13.8
	DRY DENSITY LB/CU FT	γd_c	123.8	122.0
	SATURATION, %	S_c	93.0	96.0
	VOID RATIO	e_c	0.37	0.39
	FINAL BACK PRESSURE, T/SQ FT	u_o	0.0	0.0
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1.0	4.0
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	1.07	1.69
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	31.5	32.3
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	1.07	1.69
INITIAL DIAMETER, IN.		D_o	1.38	1.37
INITIAL HEIGHT, IN.		H_o	3.00	2.99

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS S andy clay, CL

LL 21 | PL 12 | PI 9 | G_s 2.71

TYPE OF SPECIMEN UNDISTURBED | TYPE OF TEST Q

REMARKS: Gray brown. Torvane=0.56TSF. Slightly organic, slightly calcareous. Material becomes more sandy toward the top.

PROJECT CHASKA; CENCS-IA-90-78-ED-GH

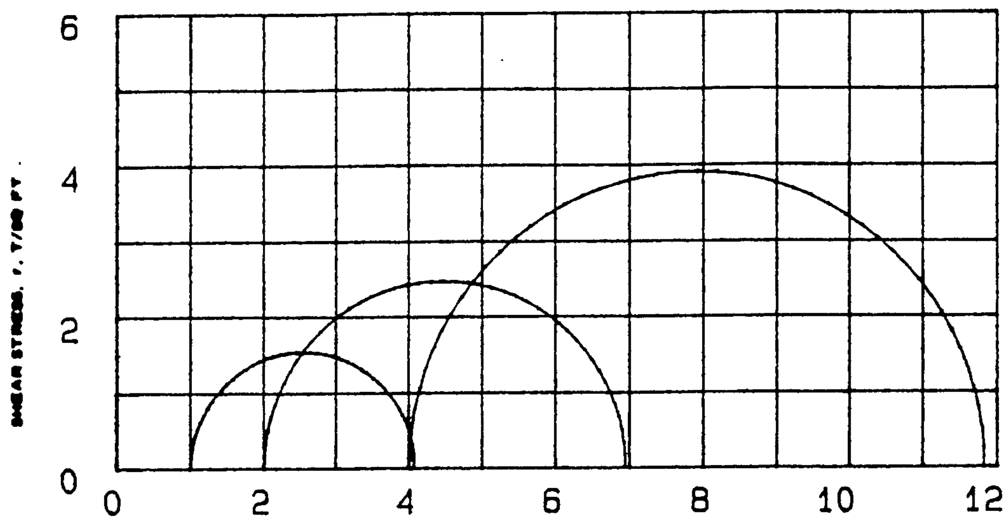
BORING NO 90-139 MU | SAMPLE NO. S-5

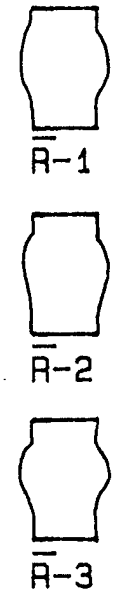
DEPTH ELEV 54'-56'

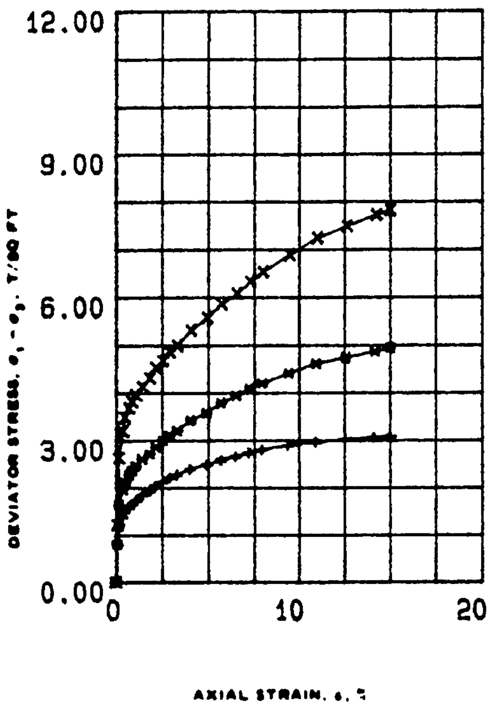
LABORATORY 90/358 | DATE 10-30-90

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906) FIGURE 22
REV JUNE 1970







			1 (+)	2 (*)	3 (X)	
SPECIMEN NO.			1 (+)	2 (*)	3 (X)	
INITIAL	WATER CONTENT, %	w_o	13.1	12.8	12.3	
	DRY DENSITY LB/CU FT	γd_o	123.9	124.3	124.2	
	SATURATION, %	S_o	97	96	92	
	VOID RATIO	e_o	.37	.36	.36	
BEFORE SHEAR	WATER CONTENT, %	w_c	13.5	11.4	11.4	
	DRY DENSITY LB/CU FT	γd_c	125.8	129.7	129.7	
	SATURATION, %	S_c	100	100	100	
	VOID RATIO	e_c	.34	.3	.3	
	FINAL BACK PRESSURE, T/SQ FT	u_o	4.823	4.823	4.823	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1	2	4	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	3.079	4.939	7.821	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	1509	1504	1498	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	3.079	4.939	7.821	
INITIAL DIAMETER, IN.		D_o	1.35	1.37	1.36	
INITIAL HEIGHT, IN.		H_o	2.99	3	2.99	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Sandy clay, CL B-Value 1.0 1.0 1.0

LL 21	PL 12	PI 9	G_s 2.71	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST RBAR

REMARKS: Gray brown. Torvane=0.56TSF. Slightly organic, slightly calcareous. Material becomes more sandy toward the top.

PROJECT CHASKA; CENCS-IA-90-78-ED-GH

BORING NO 90-139 MU SAMPLE NO. S-5

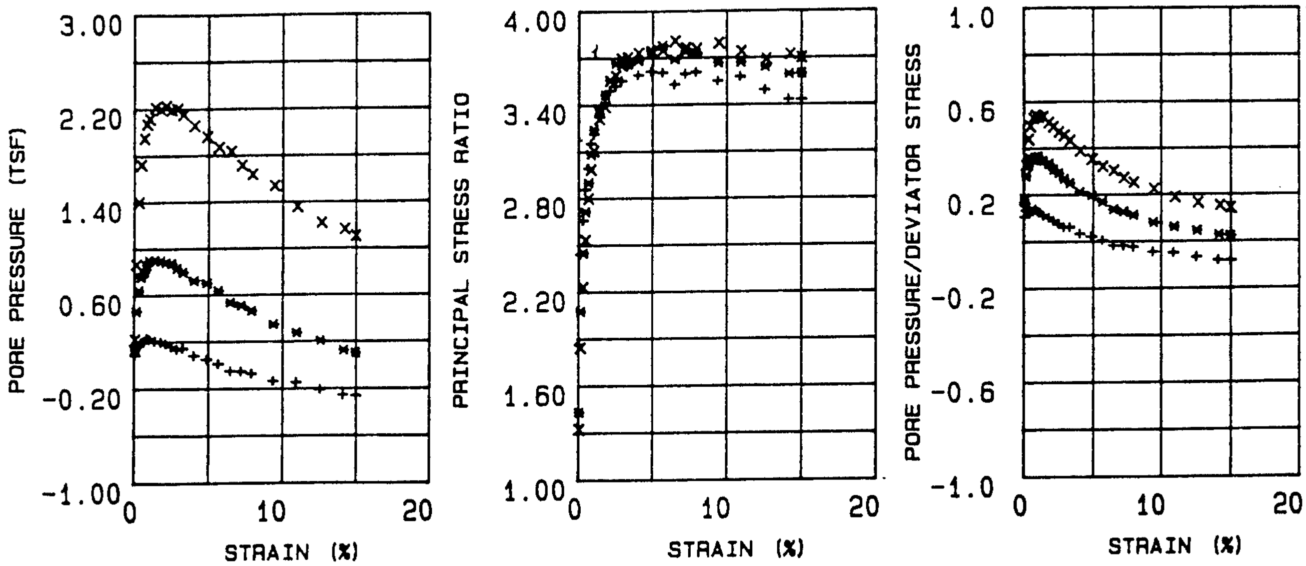
DEPTH ELEV 54'-56'

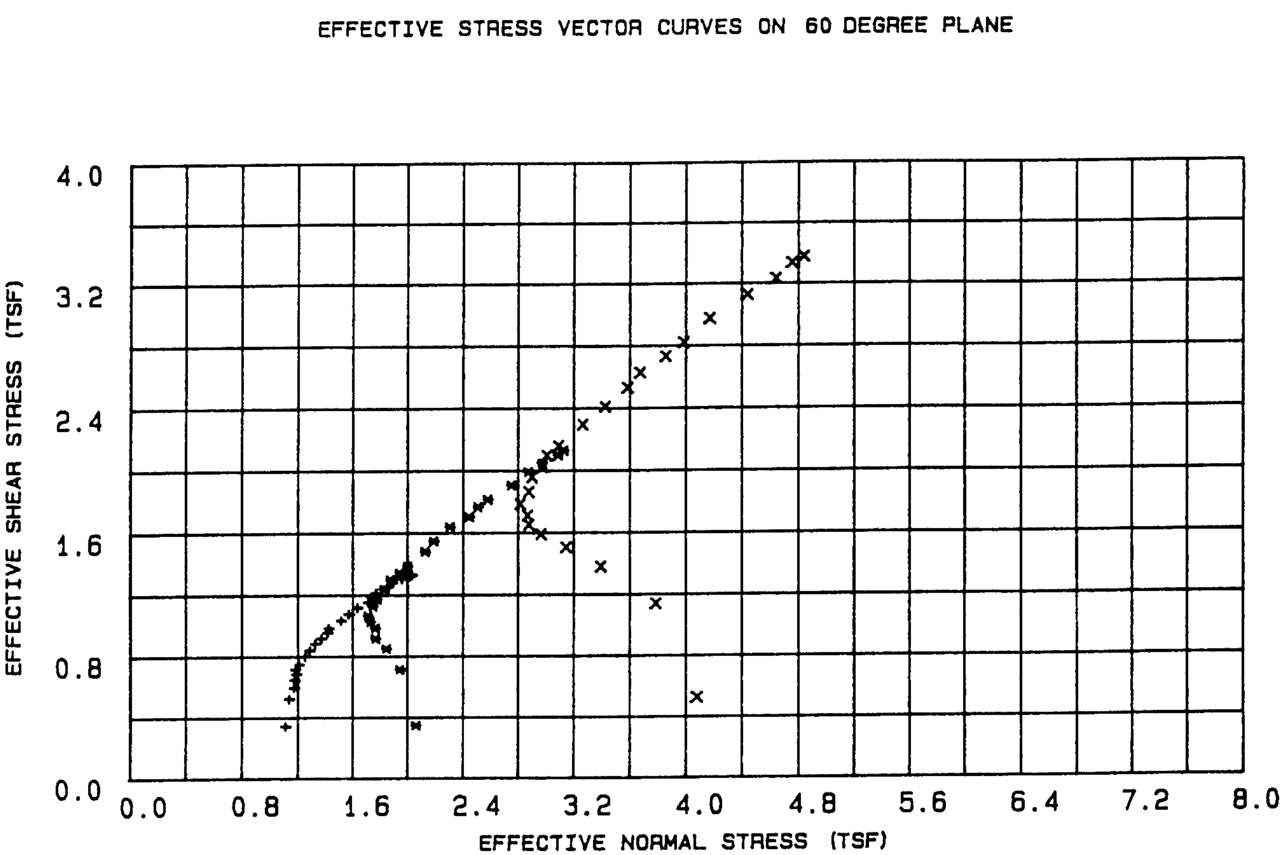
LABORATORY 90/358 DATE 10-04-90

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)
REV JUNE 1970

FIGURE 23





LEGEND	
+ = 1	TSF
* = 2	TSF
X = 4	TSF

PROJECT	CHASKA: CENCS-IA-90-78-ED-GH
BORING NO.	90-139 MU
SAMPLE NO.	S-5
DEPTH/ELEV	54'-56'
MRD LAB NO.	90/358

FIGURE 24

FIGURE D-168

R

Table 7 - Triaxial $\bar{R}$ Test Results

Project : CHASKA; CENCS-IA-90-78-ED-GH
Boring Number : 90-139 MU
Sample Number : S-5
Depth : 54'-56'
Confining Pressure : 1 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.07	0.790	0.084	1.862	0.106	1.112	0.341
30	0.16	1.208	0.162	2.441	0.134	1.137	0.521
45	0.35	1.376	0.170	2.658	0.124	1.171	0.594
60	0.49	1.496	0.193	2.855	0.130	1.177	0.646
90	0.71	1.586	0.204	2.991	0.129	1.189	0.685
120	0.87	1.658	0.230	3.151	0.139	1.180	0.715
150	1.06	1.728	0.219	3.214	0.127	1.209	0.746
180	1.42	1.851	0.204	3.324	0.110	1.254	0.799
210	1.82	1.943	0.195	3.413	0.101	1.286	0.839
240	2.14	2.045	0.179	3.492	0.088	1.327	0.883
300	2.52	2.127	0.156	3.520	0.074	1.371	0.918
360	2.90	2.218	0.131	3.553	0.060	1.418	0.957
420	3.30	2.279	0.139	3.645	0.061	1.425	0.983
480	4.03	2.392	0.077	3.590	0.032	1.515	1.033
540	4.88	2.490	0.046	3.611	0.019	1.571	1.075
600	5.66	2.589	0.006	3.604	0.003	1.635	1.117
720	6.46	2.667	-0.055	3.528	-0.020	1.715	1.151
840	7.19	2.745	-0.058	3.596	-0.021	1.738	1.185
960	7.92	2.805	-0.077	3.606	-0.027	1.771	1.211
1080	9.38	2.902	-0.139	3.549	-0.047	1.858	1.253
1200	10.89	2.967	-0.152	3.577	-0.051	1.887	1.281
1320	12.52	3.023	-0.214	3.491	-0.070	1.962	1.305
1440	14.10	3.060	-0.260	3.429	-0.084	2.017	1.321
1508	15.00	3.079	-0.268	3.428	-0.086	2.030	1.329

Table 8 - Triaxial $\bar{R}$ Test Results

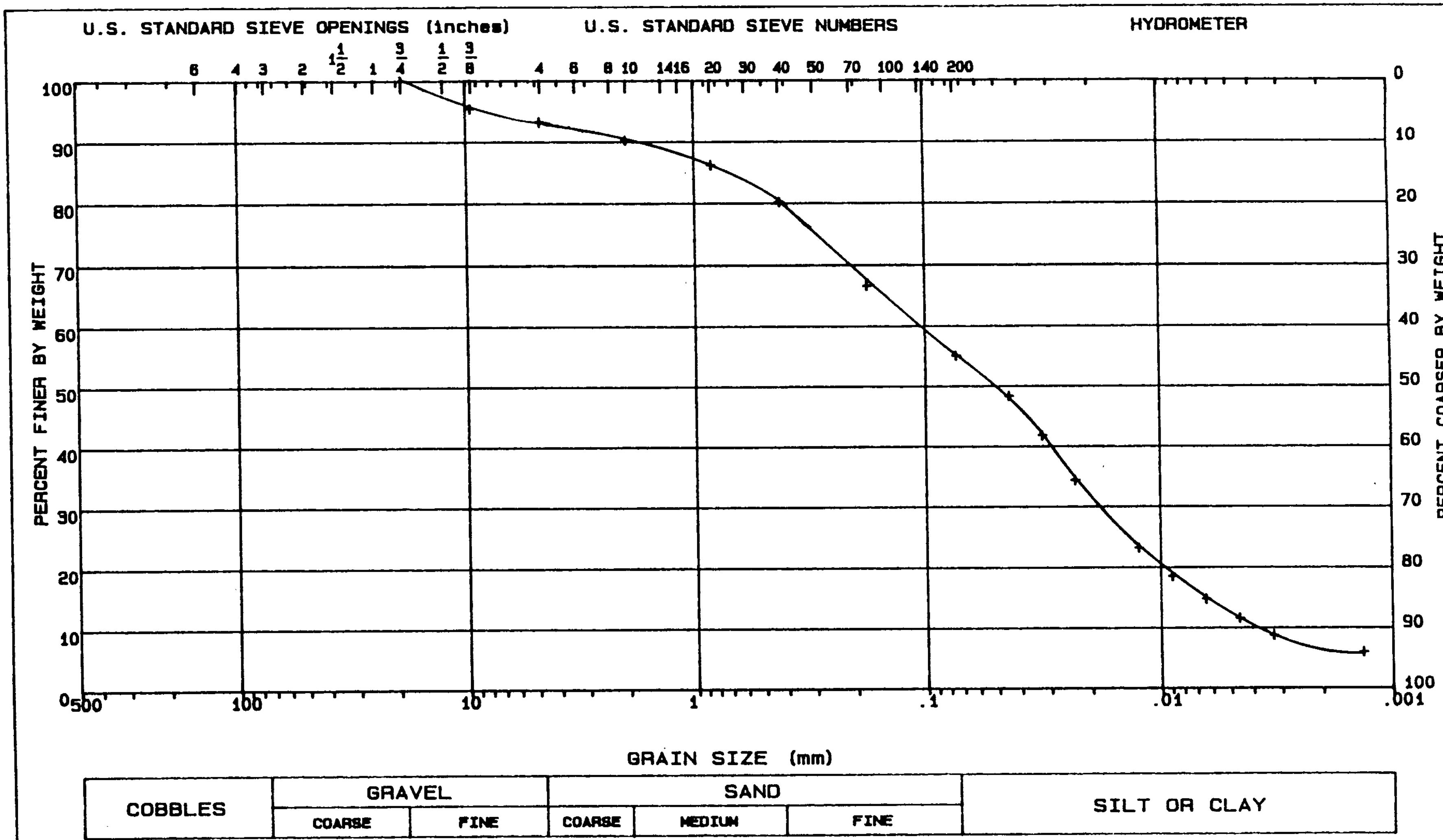
Project : CHASKA; CENCS-IA-90-78-ED-GH
Boring Number : 90-139 MU
Sample Number : S-5
Depth : 54'-56'
Confining Pressure : 2 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.07	0.805	0.136	1.432	0.169	2.063	0.347
30	0.17	1.651	0.464	2.075	0.281	1.945	0.713
45	0.35	1.969	0.641	2.449	0.326	1.846	0.850
60	0.50	2.125	0.759	2.713	0.358	1.767	0.917
90	0.71	2.279	0.799	2.899	0.351	1.765	0.984
120	0.87	2.374	0.859	3.082	0.362	1.729	1.025
150	1.07	2.468	0.899	3.242	0.365	1.712	1.065
180	1.42	2.615	0.901	3.379	0.345	1.746	1.129
210	1.82	2.720	0.896	3.465	0.330	1.777	1.174
240	2.15	2.866	0.879	3.557	0.307	1.831	1.237
300	2.53	3.009	0.871	3.665	0.290	1.874	1.299
360	2.91	3.111	0.827	3.651	0.266	1.943	1.343
420	3.32	3.212	0.794	3.662	0.248	2.001	1.386
480	4.05	3.433	0.721	3.684	0.211	2.129	1.482
540	4.90	3.586	0.697	3.751	0.195	2.191	1.548
600	5.68	3.797	0.634	3.779	0.167	2.306	1.639
720	6.49	3.946	0.532	3.689	0.135	2.445	1.703
840	7.22	4.096	0.505	3.740	0.124	2.509	1.768
960	7.95	4.205	0.460	3.730	0.110	2.581	1.815
1080	9.42	4.417	0.343	3.665	0.078	2.750	1.906
1200	10.94	4.616	0.270	3.668	0.059	2.873	1.992
1320	12.57	4.745	0.201	3.638	0.043	2.974	2.048
1440	14.16	4.869	0.120	3.590	0.025	3.085	2.101
1503	15.00	4.939	0.096	3.595	0.020	3.126	2.132

Table 9 - Triaxial $\overline{R}$ Test Results

Project : CHASKA; CENCS-IA-90-78-ED-GH
Boring Number : 90-139 MU
Sample Number : S-5
Depth : 54'-56'
Confining Pressure : 4 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.07	1.213	0.218	1.321	0.181	4.082	0.523
30	0.17	2.638	0.865	1.842	0.328	3.788	1.139
45	0.36	3.194	1.398	2.228	0.438	3.393	1.379
60	0.50	3.488	1.721	2.531	0.494	3.142	1.505
90	0.71	3.684	1.949	2.796	0.529	2.963	1.590
120	0.88	3.825	2.071	2.983	0.542	2.876	1.651
150	1.07	3.965	2.115	3.103	0.534	2.867	1.711
180	1.43	4.133	2.211	3.310	0.535	2.812	1.784
210	1.83	4.315	2.193	3.388	0.509	2.875	1.862
240	2.16	4.536	2.224	3.554	0.491	2.899	1.958
300	2.54	4.680	2.189	3.584	0.468	2.970	2.020
360	2.93	4.859	2.198	3.696	0.453	3.005	2.097
420	3.33	4.999	2.150	3.701	0.431	3.088	2.157
480	4.07	5.314	2.053	3.730	0.387	3.263	2.294
540	4.93	5.580	1.957	3.732	0.351	3.425	2.409
600	5.71	5.864	1.866	3.747	0.319	3.586	2.531
720	6.52	6.087	1.831	3.806	0.301	3.676	2.627
840	7.26	6.328	1.708	3.761	0.270	3.859	2.731
960	7.99	6.531	1.630	3.755	0.250	3.987	2.819
1080	9.47	6.888	1.533	3.793	0.223	4.172	2.973
1200	10.99	7.243	1.354	3.738	0.187	4.439	3.126
1320	12.64	7.487	1.215	3.688	0.163	4.639	3.231
1440	14.23	7.722	1.158	3.717	0.150	4.754	3.333
1497	15.00	7.821	1.099	3.696	0.141	4.838	3.375



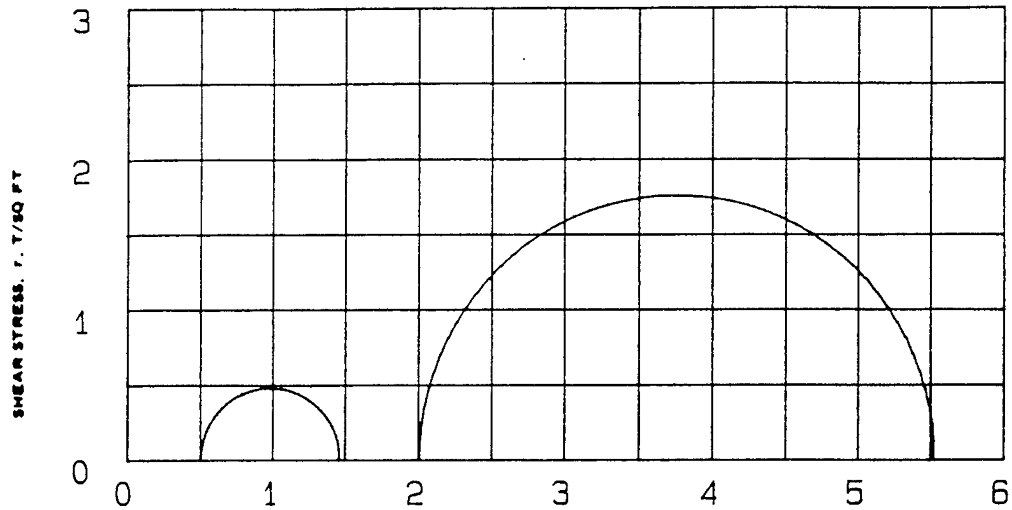
LL = 21	PL = 12	PI = 9	Gs = 2.71	NAT w = %

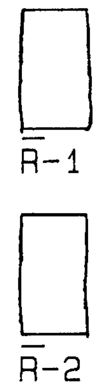
CLASSIFICATION Sandy clay, CL

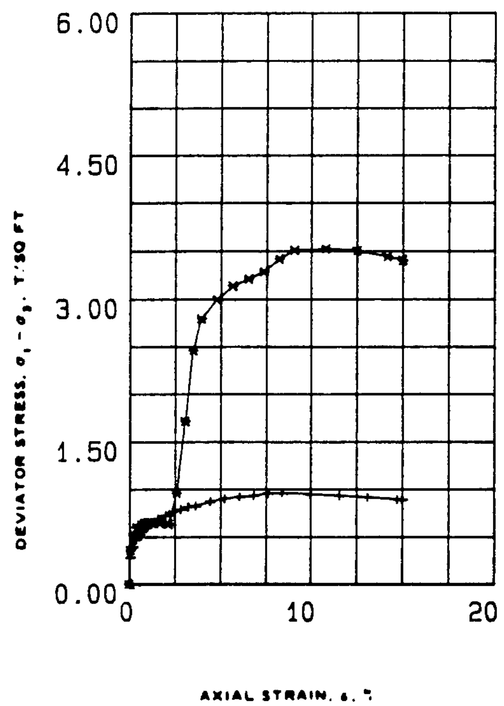
GRADATION CURVE

PROJECT	CHASKA; CENCS-IA-90-78-ED-GH
DATE	10-05-90
BORING NO.	90-139 MU
SAMPLE NO.	S-5
DEPTH/ELEV	54'-56'
MRD LAB NO.	90/358

FIGURE 25







NORMAL STRESS, σ, T/SQ FT

			1 (+)	2 (*)		
SPECIMEN NO.			1 (+)	2 (*)		
INITIAL	WATER CONTENT, %	w_o	90.7	130.3		
INITIAL	DRY DENSITY LB/CU FT	γ_{d_o}	44.3	35.7		
INITIAL	SATURATION, %	S_o	89	96		
INITIAL	VOID RATIO	e_o	2.58	3.44		
BEFORE SHEAR	WATER CONTENT, %	w_c	94.6	88.5		
BEFORE SHEAR	DRY DENSITY LB/CU FT	γ_{d_c}	48.9	50.3		
BEFORE SHEAR	SATURATION, %	S_c	100	100		
BEFORE SHEAR	VOID RATIO	e_c	2.24	2.15		
BEFORE SHEAR	FINAL BACK PRESSURE, T/SQ FT	u_o	3.383	3.383		
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.5	2		
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	0.961	3.522		
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	960	1080		
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	0.888	3.401		
INITIAL DIAMETER, IN.		D_o	1.4	1.39		
INITIAL HEIGHT, IN.		H_o	2.99	2.99		

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS FAt clay, ~~CH~~ SC B-Value 1.0 1.0 1.0

LL	PL	PI	G_s	TYPE OF SPECIMEN	TYPE OF TEST
75	35	40	2.54	UNDISTURBED	RBAR

REMARKS: Dark brown-black. Highly calcareous.

PROJECT CHASKA; CENCS-IA-91-45-ED-GH

BORING NO 90-143 SAMPLE NO. W-1

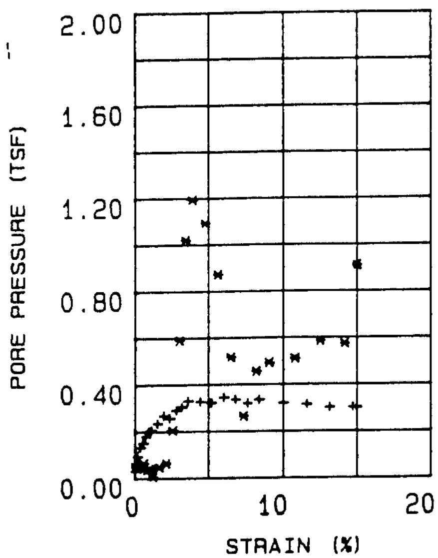
DEPTH ELEV 4'-5'

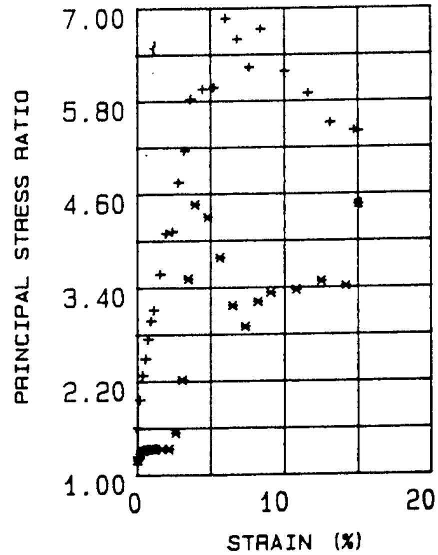
LABORATORY 839 DATE 04-17-91

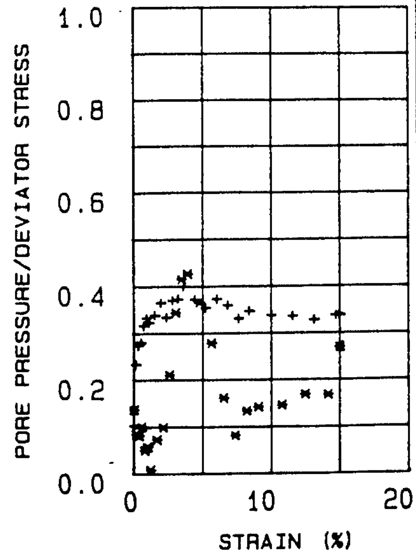
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT *(EM 1110-2-1906)*

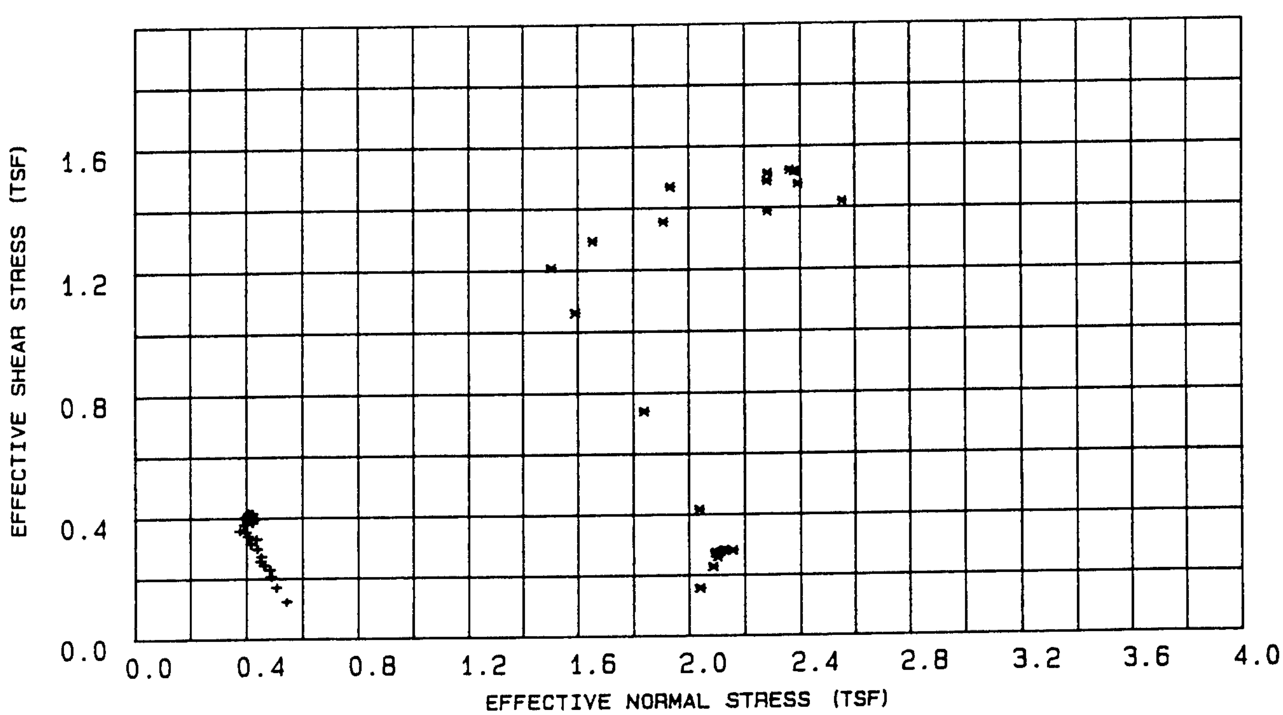
FIGURE 1







EFFECTIVE STRESS VECTOR CURVES ON 60 DEGREE PLANE



LEGEND

+ = .5 TSF

* = 2 TSF

PROJECT	CHASKA: CENCS-IA-91-45-ED-GH
BORING NO.	90-143
SAMPLE NO.	W-1
DEPTH/ELEV	4'-5'
MRD LAB NO.	839

FIGURE 2

R

Table 1 - Triaxial $\bar{R}$ Test Results

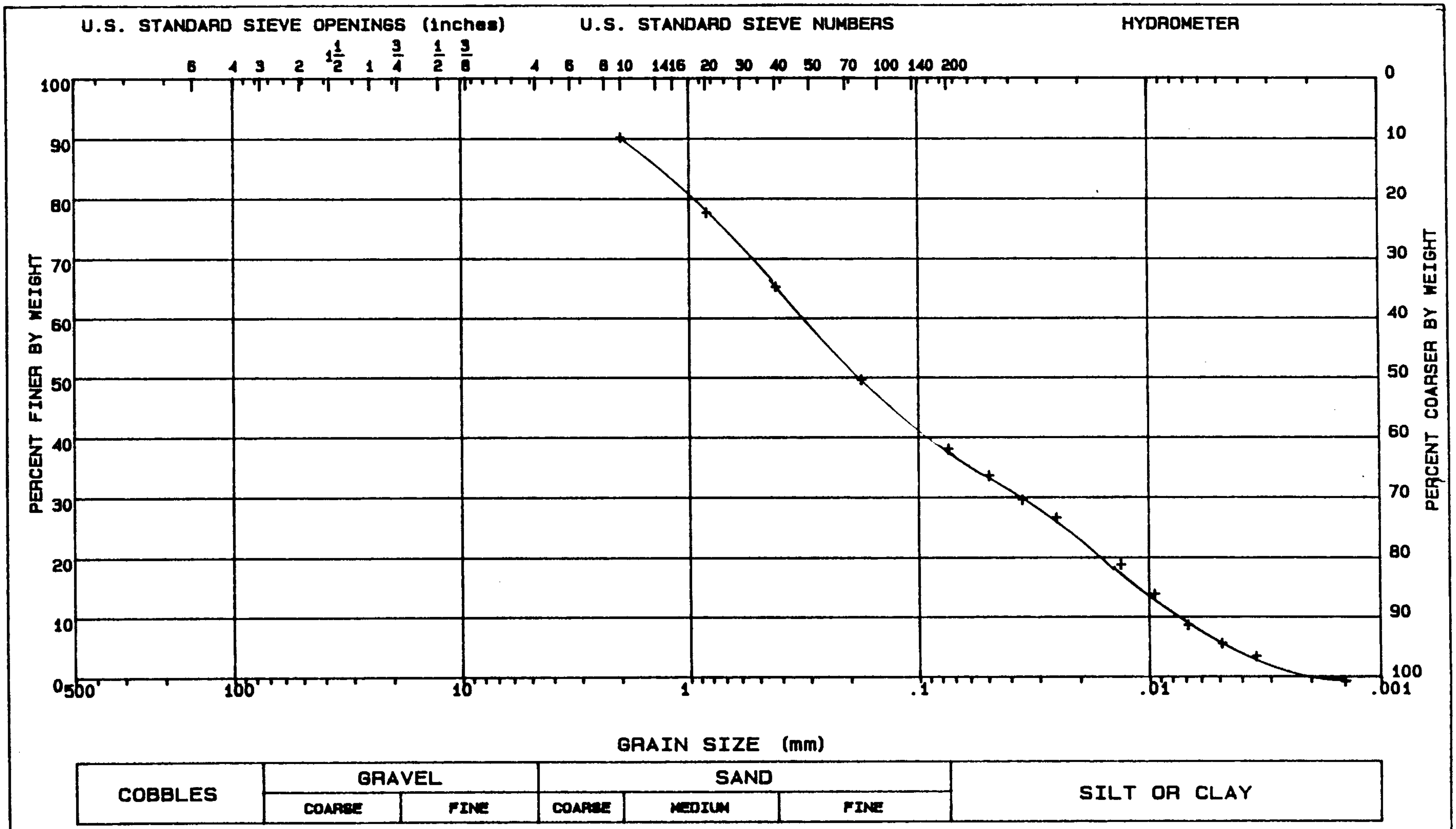
Project : CHASKA; CENCS-IA-91-45-ED-GH
Boring Number : 90-143
Sample Number : W-1
Depth : 4'-5'
Confining Pressure : .5 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.05	0.282	0.028	1.598	0.102	0.542	0.122
30	0.20	0.392	0.092	1.961	0.234	0.505	0.169
45	0.39	0.474	0.130	2.280	0.274	0.487	0.205
60	0.59	0.527	0.148	2.496	0.281	0.482	0.228
90	0.76	0.562	0.177	2.740	0.316	0.462	0.242
120	0.96	0.596	0.198	2.975	0.333	0.450	0.257
150	1.15	0.630	0.203	3.117	0.322	0.453	0.272
180	1.57	0.688	0.232	3.567	0.338	0.438	0.297
210	1.98	0.727	0.265	4.090	0.365	0.415	0.314
240	2.40	0.765	0.254	4.114	0.333	0.436	0.330
300	2.82	0.786	0.290	4.742	0.370	0.404	0.339
360	3.21	0.815	0.304	5.152	0.373	0.398	0.352
420	3.63	0.825	0.329	5.828	0.399	0.375	0.356
480	4.44	0.873	0.324	5.956	0.371	0.392	0.377
540	5.22	0.903	0.319	5.974	0.353	0.404	0.390
600	6.03	0.922	0.343	6.866	0.372	0.385	0.398
720	6.82	0.933	0.333	6.596	0.358	0.398	0.403
840	7.63	0.960	0.316	6.230	0.330	0.422	0.414
960	8.41	0.961	0.332	6.729	0.346	0.406	0.415
1080	10.01	0.945	0.317	6.179	0.336	0.417	0.408
1200	11.58	0.929	0.310	5.894	0.334	0.420	0.401
1320	13.12	0.914	0.297	5.510	0.326	0.429	0.394
1440	14.71	0.888	0.298	5.409	0.336	0.422	0.383
1462	15.00	0.888	0.298	5.400	0.336	0.422	0.383

Table 2 - Triaxial $\bar{R}$ Test Results

Project : CHASKA; CENCS-IA-91-45-ED-GH
Boring Number : 90-143
Sample Number : W-1
Depth : 4'-5'
Confining Pressure : 2 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.05	0.361	0.049	1.185	0.136	2.040	0.156
30	0.21	0.526	0.044	1.269	0.083	2.086	0.227
45	0.42	0.601	0.047	1.308	0.080	2.102	0.259
60	0.63	0.630	0.062	1.325	0.099	2.094	0.272
90	0.82	0.649	0.032	1.330	0.049	2.129	0.280
120	1.03	0.656	0.037	1.334	0.057	2.125	0.283
150	1.24	0.651	0.004	1.326	0.007	2.157	0.281
180	1.69	0.643	0.046	1.329	0.072	2.113	0.277
210	2.14	0.634	0.062	1.327	0.098	2.095	0.274
240	2.59	0.964	0.203	1.537	0.211	2.036	0.416
300	3.05	1.715	0.589	2.216	0.344	1.836	0.740
360	3.47	2.460	1.019	3.508	0.415	1.590	1.062
420	3.92	2.798	1.192	4.462	0.426	1.501	1.208
480	4.79	2.997	1.090	4.294	0.364	1.652	1.294
540	5.64	3.139	0.869	3.775	0.277	1.908	1.355
600	6.51	3.214	0.514	3.163	0.160	2.282	1.387
720	7.36	3.289	0.261	2.891	0.080	2.553	1.419
840	8.23	3.421	0.455	3.214	0.133	2.392	1.476
960	9.08	3.511	0.492	3.328	0.141	2.377	1.515
1080	10.80	3.522	0.510	3.364	0.145	2.362	1.520
1200	12.50	3.501	0.585	3.475	0.168	2.282	1.511
1320	14.16	3.441	0.572	3.410	0.167	2.280	1.485
1378	15.00	3.401	0.909	4.460	0.269	1.933	1.468
1378	15.00	3.401	0.909	4.460	0.269	1.933	1.468



LL = 75	PL = 35	PI = 40	Gs = 2.54	NAT w = %

CLASSIFICATION Fat clay, ~~CH~~ SC
Dark brown-black
Highly calcareous

GRADATION CURVE

PROJECT	CHASKA; CENCS-IA-91-45-ED-GH
DATE	03-27-91
BORING NO.	90-143
SAMPLE NO.	W-1
DEPTH/ELEV	4'-5'
MRD LAB NO.	839

FIGURE 3

CLASSIFICATION TEST REQUEST

PROJECT: Chaska Flood Control Stage 3, East Creek

MRD LAB. NO.: 839

ACCOMPANYING TEST: X, R

REQUEST NO.: CENCS-IA-91-45-ED-01

CONTAINER - TYPE: 3" TUBE

NO.:

SAMPLE IDENTIFICATION: 90-143 W-1 4.0'-5.0'

SAMPLE IDENTIFICATION:

Structure: ( ) Brittle ( ) Plastic ( )

Consistency: Undisturbed ( ) Soft ( ) Med ( ) Stiff ( ) Hard

Remolded ( ) Insensitive ( ) Sl. Sens. ( ) Sensitive

PL Thread: Strength ( ) Low ( ) Med ( ) High ( )

Shine ( ) None ( ) Dull ( ) Gloss ( ) H. Gloss ( )

Shake Test ( ) None ( ) Slow ( ) Fast ( ) Rapid ( )

Torvane: n/a

Odor: none

Color: dark brown black

Cementation: high - reactive to HCl

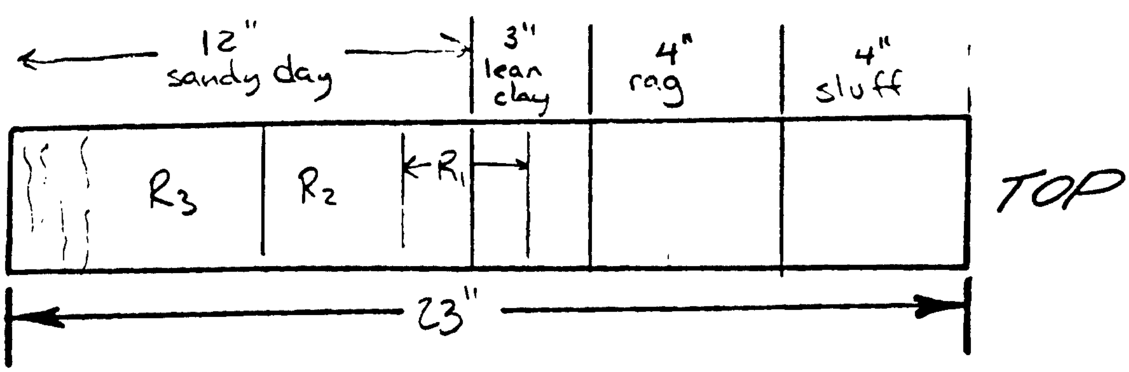
Disturbance:

Date Core Opened: 2/27/91

Est. Max. Particle Size:

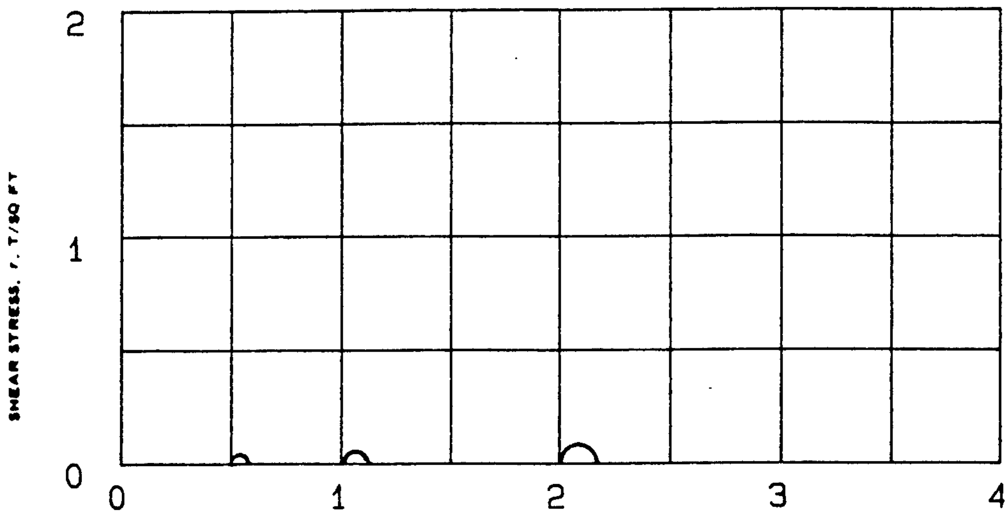
Sketch: (Core description and specimen location)

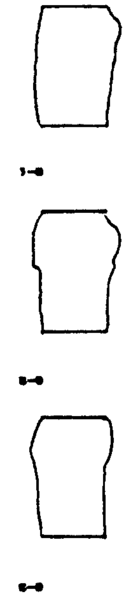
Remarks: no tags, water squeezed from bottom of tube.

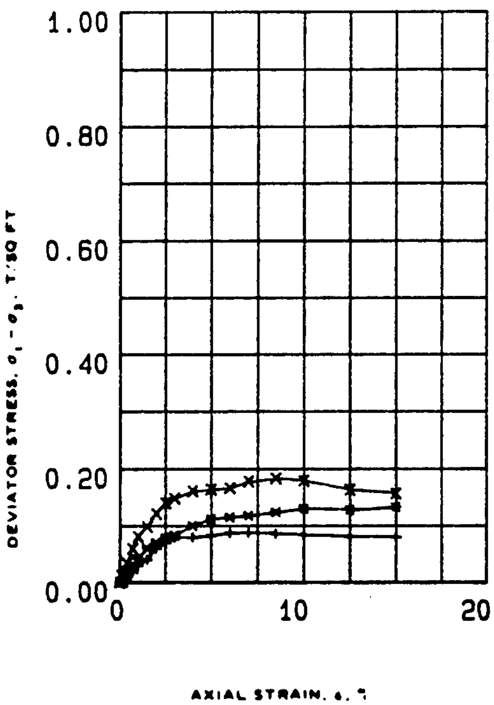


Technician ____________

FIGURE D-178







			1 (+)	2 (*)	3 (X)
SPECIMEN NO.			1 (+)	2 (*)	3 (X)
INITIAL	WATER CONTENT, %	w_o	99.8	104.4	102.9
INITIAL	DRY DENSITY LB/CU FT	γd_o	44.9	45.7	40.5
INITIAL	SATURATION, %	S_o	100.0	100.0	92.0
INITIAL	VOID RATIO	e_o	2.27	2.21	2.63
BEFORE SHEAR	WATER CONTENT, %	w_c	94.4	91.4	139.2
BEFORE SHEAR	DRY DENSITY LB/CU FT	γd_c	45.0	45.8	40.6
BEFORE SHEAR	SATURATION, %	S_c	98.0	98.0	100.0
BEFORE SHEAR	VOID RATIO	e_c	2.26	2.20	2.61
BEFORE SHEAR	FINAL BACK PRESSURE, T/SQ FT	u_o	0.0	0.0	0.0
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	0.5	1.0	2.0
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	0.09	0.13	0.18
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	13.8	24.0	9.0
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	0.08	0.13	0.16
INITIAL DIAMETER, IN.		D_o	1.36	1.39	1.39
INITIAL HEIGHT, IN.		H_o	3.05	2.96	2.96

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Organic Silt, OH

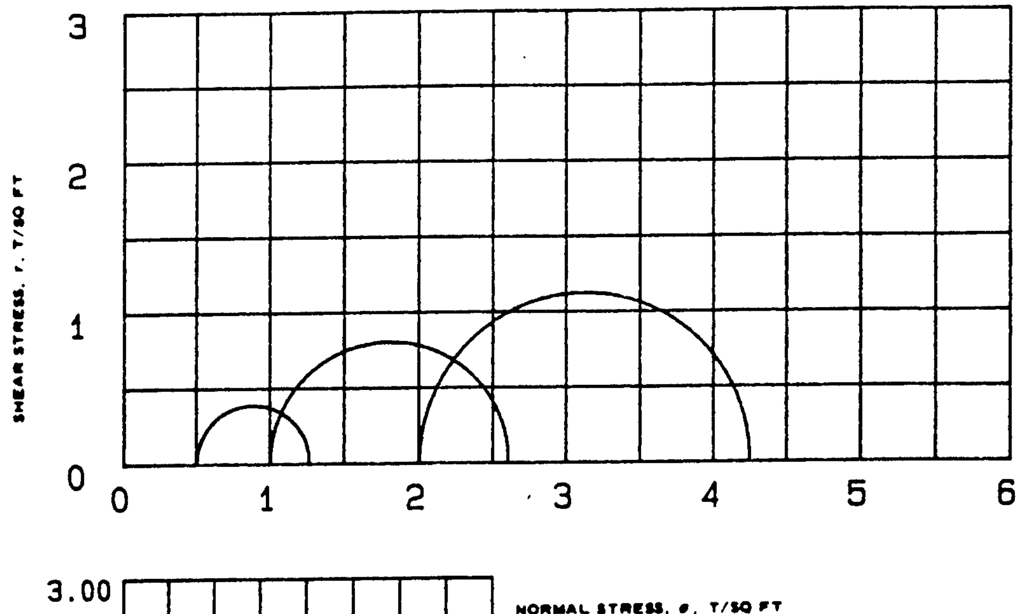
LL 165	PL 98	PI 67	Gs 2.35	TYPE OF SPECIMEN	UNDISTURBED	TYPE OF TEST	Q

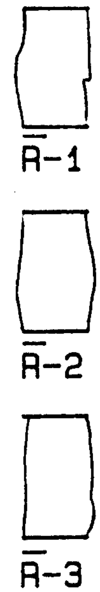
REMARKS: Dark brown. Too soft for Torvane calcareous.

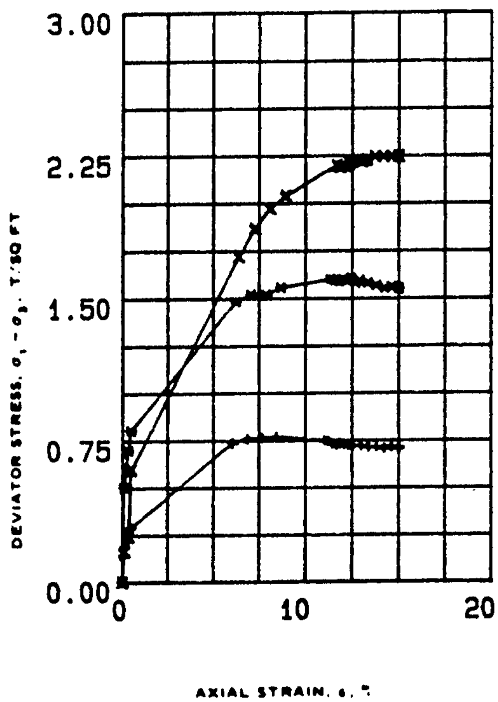
PROJECT	CHASKA; CENCS-IA-91-45-ED-GH		
BORING NO	90-143	SAMPLE NO.	W-2
DEPTH ELEV	12'-14'		
LABORATORY	839	DATE	03-27-91

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906) FIGURE 4
REV JUNE 1970







			1 (+)	2 (*)	3 (X)
SPECIMEN NO.			1 (+)	2 (*)	3 (X)
INITIAL	WATER CONTENT, %	w_o	119.7	133.9	134.4
	DRY DENSITY LB/CU FT	γd_o	38	35.2	35.2
	SATURATION, %	S_o	98	99	100
	VOID RATIO	e_o	2.86	3.17	3.17
BEFORE SHEAR	WATER CONTENT, %	w_c	102.3	102.1	90.4
	DRY DENSITY LB/CU FT	γd_c	43	43.4	46.9
	SATURATION, %	S_c	100	100	100
	VOID RATIO	e_c	2.41	2.38	2.13
	FINAL BACK PRESSURE, T/SQ FT	u_o	3.383	3.383	3.383
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.5	1	2
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	0.768	1.606	2.245
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	150	420	600
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	0.707	1.548	2.245
INITIAL DIAMETER, IN.		D_o	1.39	1.38	1.39
INITIAL HEIGHT, IN.		H_o	2.99	2.99	2.98

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Organic Silt, OH B-Value 1.0 1.0 1.0

LL 165	PL 98	PI 67	G_s 2.35	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST RBAR

REMARKS Dark brown. Too soft for Torvane. Calcareous.

PROJECT CHASKA; CENCS-IA-91-45-ED-GH

BORING NO 90-143 SAMPLE NO. W-2

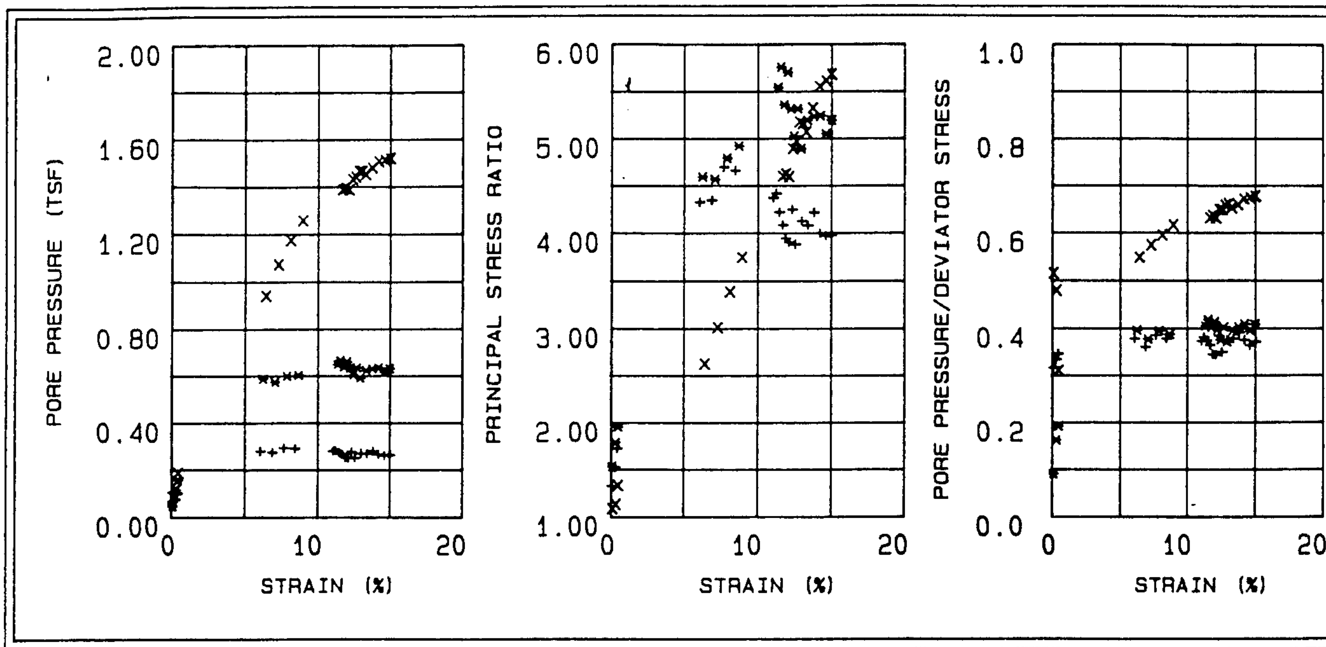
DEPTH ELEV 12'-14'

LABORATORY 839 DATE 03-29-91

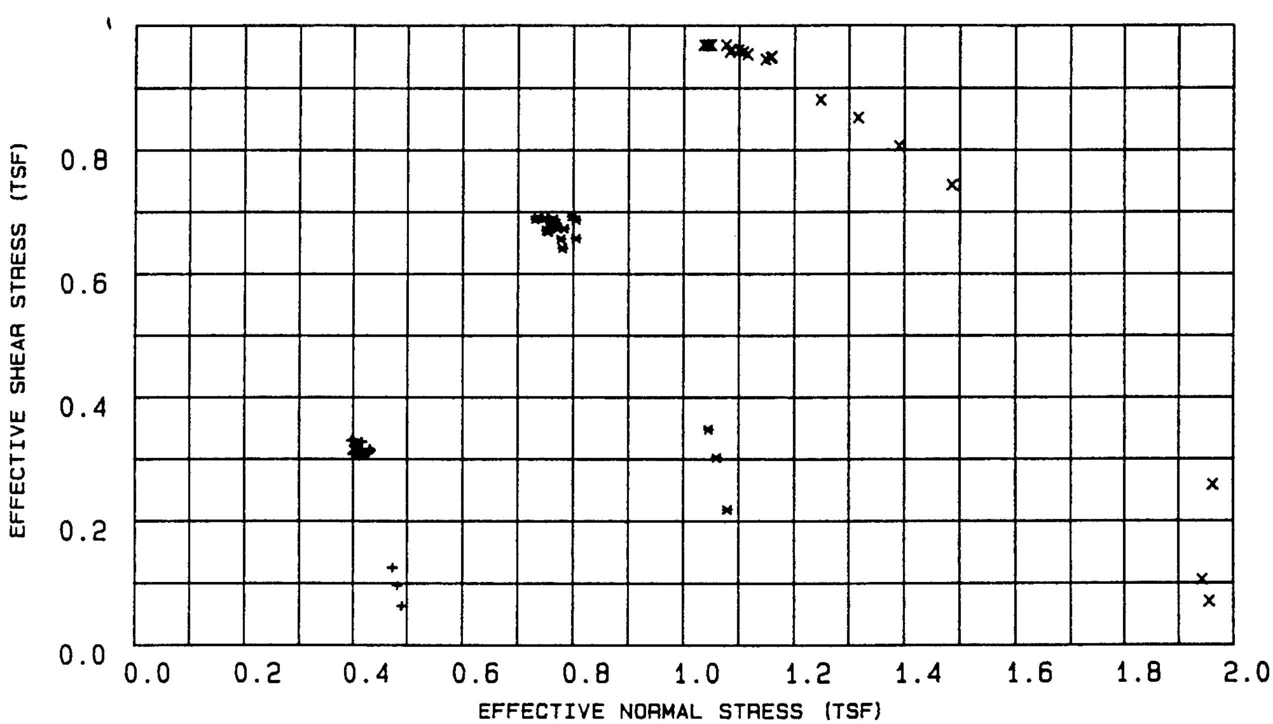
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO 2089 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)
REV JUNE 1970

FIGURE 5



EFFECTIVE STRESS VECTOR CURVES ON 60 DEGREE PLANE



LEGEND

+ = .5 TSF

✱ = 1 TSF

X = 2 TSF

PROJECT	CHASKA: CENCS-IA-91-45-ED-GH
BORING NO.	90-143
SAMPLE NO.	W-2
DEPTH/ELEV	12'-14'
MRD LAB NO.	839

FIGURE 6

R

Table 4 - Triaxial $\overline{R}$ Test Results

Project : CHASKA; CENCS-IA-91-45-ED-GH
Boring Number : 90-143
Sample Number : W-2
Depth : 12'-14'
Confining Pressure : .5 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.10	0.146	0.046	1.322	0.316	0.490	0.063
30	0.32	0.222	0.074	1.522	0.334	0.481	0.096
45	0.47	0.289	0.100	1.723	0.346	0.472	0.125
60	6.06	0.738	0.278	4.327	0.378	0.405	0.318
90	6.88	0.760	0.273	4.346	0.360	0.415	0.328
120	7.68	0.764	0.293	4.695	0.385	0.396	0.330
150	8.45	0.768	0.290	4.658	0.378	0.400	0.331
180	11.03	0.747	0.278	4.368	0.373	0.407	0.322
210	11.23	0.743	0.283	4.417	0.381	0.401	0.321
240	11.45	0.730	0.273	4.215	0.374	0.408	0.315
300	11.68	0.726	0.264	4.081	0.364	0.416	0.313
360	11.87	0.731	0.251	3.941	0.344	0.430	0.316
420	12.10	0.727	0.249	3.899	0.343	0.431	0.314
480	12.32	0.723	0.277	4.245	0.384	0.402	0.312
540	12.55	0.719	0.250	3.879	0.349	0.428	0.310
600	12.97	0.720	0.270	4.124	0.375	0.408	0.311
720	13.39	0.712	0.269	4.076	0.378	0.407	0.307
840	13.81	0.713	0.278	4.213	0.391	0.398	0.308
960	14.21	0.705	0.264	3.992	0.375	0.411	0.304
1080	14.61	0.715	0.259	3.964	0.363	0.418	0.308
1198	15.00	0.707	0.262	3.973	0.371	0.413	0.305
1198	15.00	0.707	0.262	3.973	0.371	0.413	0.305

Table 5 - Triaxial $\bar{R}$ Test Results

Project : CHASKA; CENCS-IA-91-45-ED-GH
Boring Number : 90-143
Sample Number : W-2
Depth : 12'-14'
Confining Pressure : 1 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.10	0.505	0.045	1.529	0.090	1.080	0.218
30	0.33	0.699	0.113	1.788	0.162	1.060	0.302
45	0.49	0.806	0.155	1.954	0.192	1.045	0.348
60	6.24	1.484	0.587	4.593	0.396	0.780	0.641
90	7.08	1.522	0.573	4.566	0.377	0.804	0.657
120	7.90	1.520	0.599	4.792	0.395	0.777	0.656
150	8.69	1.558	0.603	4.922	0.387	0.783	0.673
180	11.35	1.600	0.648	5.542	0.405	0.748	0.690
210	11.56	1.594	0.665	5.759	0.418	0.730	0.688
240	11.78	1.587	0.636	5.355	0.401	0.757	0.685
300	12.01	1.599	0.660	5.703	0.413	0.736	0.690
360	12.22	1.593	0.630	5.311	0.396	0.764	0.688
420	12.45	1.606	0.601	5.023	0.375	0.797	0.693
480	12.68	1.579	0.634	5.314	0.402	0.757	0.682
540	12.91	1.592	0.590	4.887	0.371	0.804	0.687
600	13.34	1.579	0.623	5.193	0.395	0.768	0.681
720	13.78	1.566	0.630	5.236	0.403	0.758	0.676
840	14.22	1.553	0.634	5.241	0.409	0.750	0.670
960	14.62	1.559	0.615	5.047	0.395	0.771	0.673
1070	15.00	1.548	0.631	5.192	0.408	0.753	0.668
1070	15.00	1.548	0.631	5.192	0.408	0.753	0.668
1070	15.00	1.548	0.631	5.192	0.408	0.753	0.668

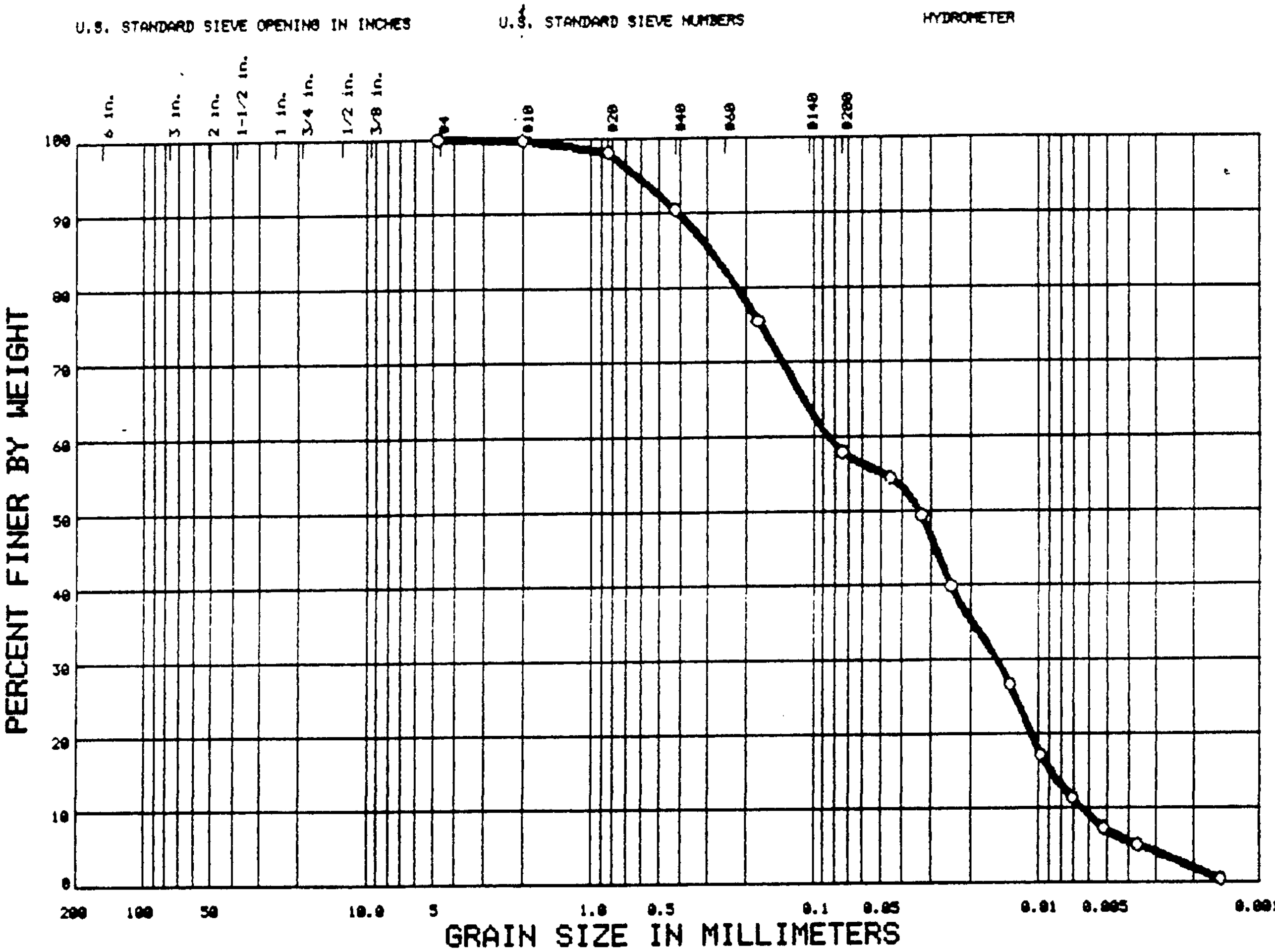
Table 6 - Triaxial $\bar{R}$ Test Results

Project : CHASKA; CENCS-IA-91-45-ED-GH
Boring Number : 90-143
Sample Number : W-2
Depth : 12'-14'
Confining Pressure : 2 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.11	0.163	0.084	1.085	0.515	1.956	0.070
30	0.34	0.243	0.117	1.129	0.479	1.943	0.105
45	0.50	0.597	0.185	1.329	0.310	1.963	0.258
60	6.41	1.721	0.941	2.625	0.548	1.485	0.743
90	7.28	1.868	1.072	3.012	0.574	1.390	0.806
120	8.12	1.974	1.173	3.387	0.595	1.316	0.852
150	8.94	2.040	1.257	3.745	0.616	1.248	0.881
180	11.67	2.200	1.389	4.599	0.632	1.156	0.949
210	11.88	2.191	1.395	4.622	0.637	1.147	0.946
240	12.11	2.200	1.387	4.591	0.631	1.158	0.950
300	12.35	2.209	1.432	4.892	0.649	1.115	0.954
360	12.56	2.219	1.442	4.975	0.650	1.107	0.958
420	12.80	2.228	1.466	5.176	0.659	1.086	0.962
480	13.04	2.218	1.466	5.158	0.662	1.083	0.958
540	13.27	2.227	1.452	5.068	0.653	1.099	0.961
600	13.72	2.245	1.480	5.322	0.660	1.076	0.969
720	14.17	2.245	1.507	5.552	0.672	1.049	0.969
840	14.61	2.245	1.513	5.610	0.675	1.043	0.969
950	15.00	2.245	1.520	5.680	0.678	1.036	0.969
950	15.00	2.245	1.520	5.680	0.678	1.036	0.969
950	15.00	2.245	1.520	5.680	0.678	1.036	0.969
950	15.00	2.245	1.520	5.680	0.678	1.036	0.969

W.O. No.
Req. No.
Contract No.

CORPS OF ENGINEERS, MISSOURI RIVER DIVISION LAB
420 SOUTH 18th STREET - OMAHA, NE 68102-2586



% COBBLES		% GRAVEL	% SAND	% SILT OR CLAY	
o	0.0	0.0	42.0	51.0	7.0

	Sample No.	Elev or Depth	Nat W%	LL	PL	PI	C_c	C_u
o	W-2	12' - 14'		165.3	97.8	67.5	0.43	13.2

CLASSIFICATION

o OH
ORGANIC SILT, OH

Remarks:

Project CHASKA FLOOD CONTROL

Lab No. 91/839

Area

Boring No. 90-143 Date 4-12-91

GRADATION CURVES

Figure 7

CLASSIFICATION TEST REQUEST

PROJECT: Chaska Flood Control Stage 3, East Creek

MRD LAB. NO.: 839

ACCOMPANYING TEST: Q, R

REQUEST NO.: CENCS-IA-91-45-ED-GH

CONTAINER - TYPE: 3' TUBE

NO.:

SAMPLE IDENTIFICATION: 90-143 W-2 12.0'-14.0'

SAMPLE IDENTIFICATION:

Structure: (✓) Brittle ( ) Plastic ( )

Consistency: Undisturbed (✓) Soft ( ) Med ( ) Stiff ( ) Hard

Remolded ( ) Insensitive ( ) Sl. Sens. ( ) Sensitive

PL Thread: Strength ( ) Low ( ) Med ( ) High ( )

Shine ( ) None ( ) Dull ( ) Gloss ( ) H. Gloss ( )

Shake Test ( ) None ( ) Slow ( ) Fast ( ) Rapid ( )

Torvane: n/a

Color: dark brown

Disturbance:

Est. Max. Particle Size:

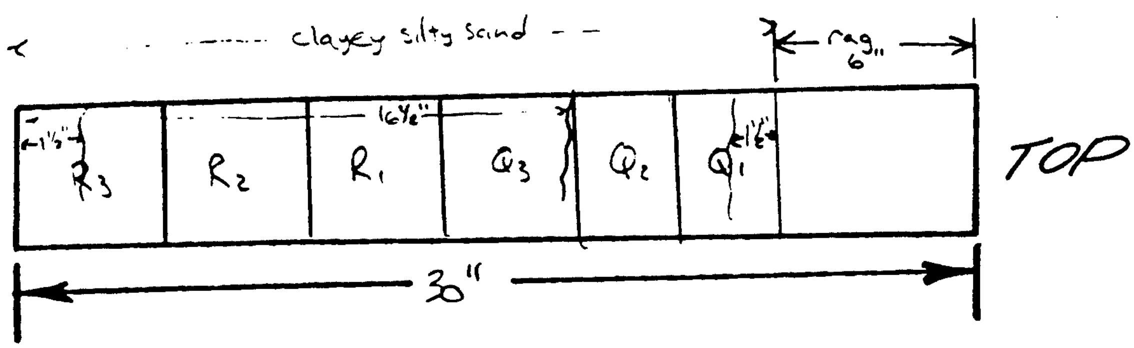
Remarks: no tag

Odor: none

Cementation: reactive to HCl

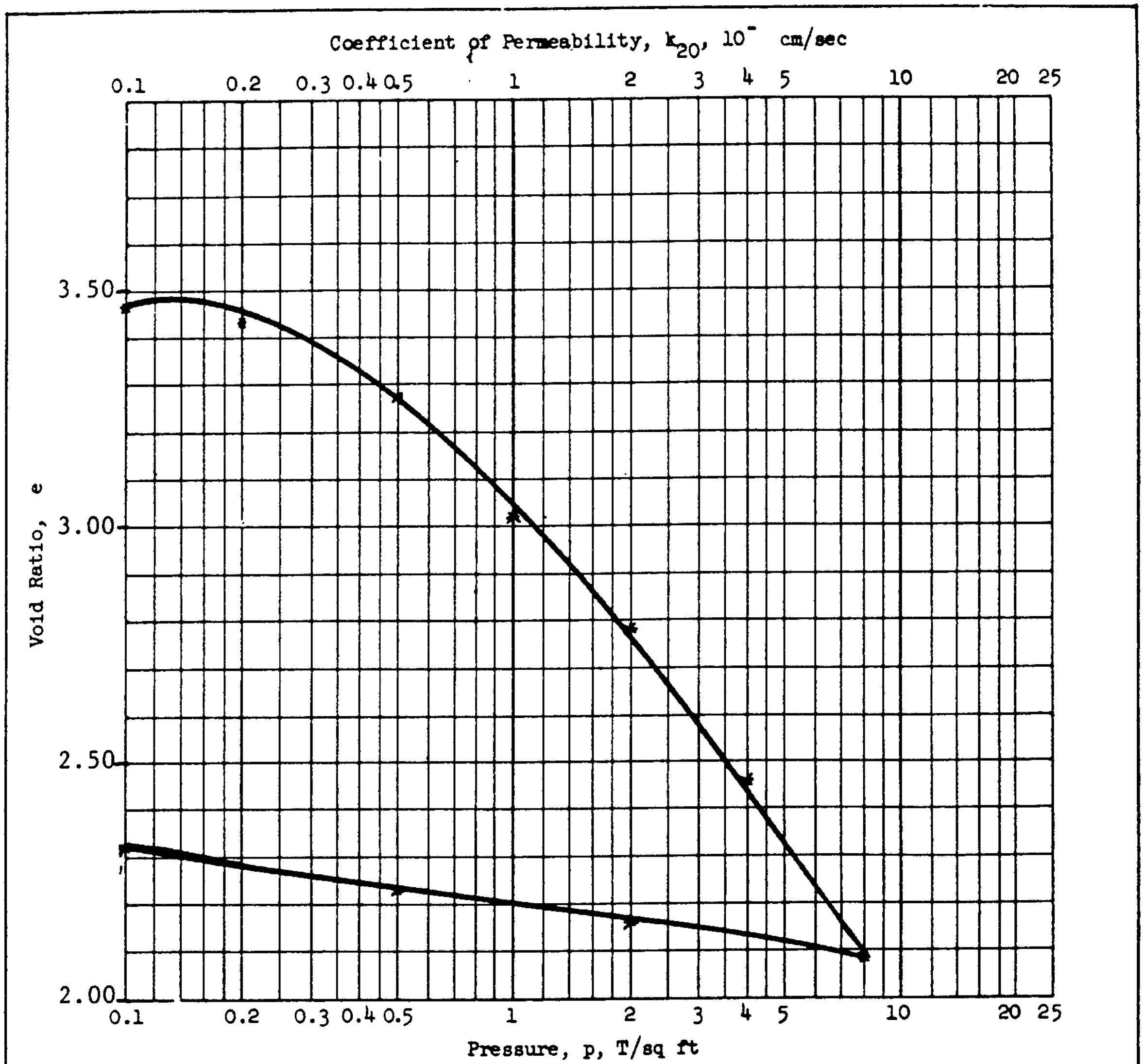
Date Core Opened: 3/27/91

Sketch: (Core description and specimen location)



Technician Mike W

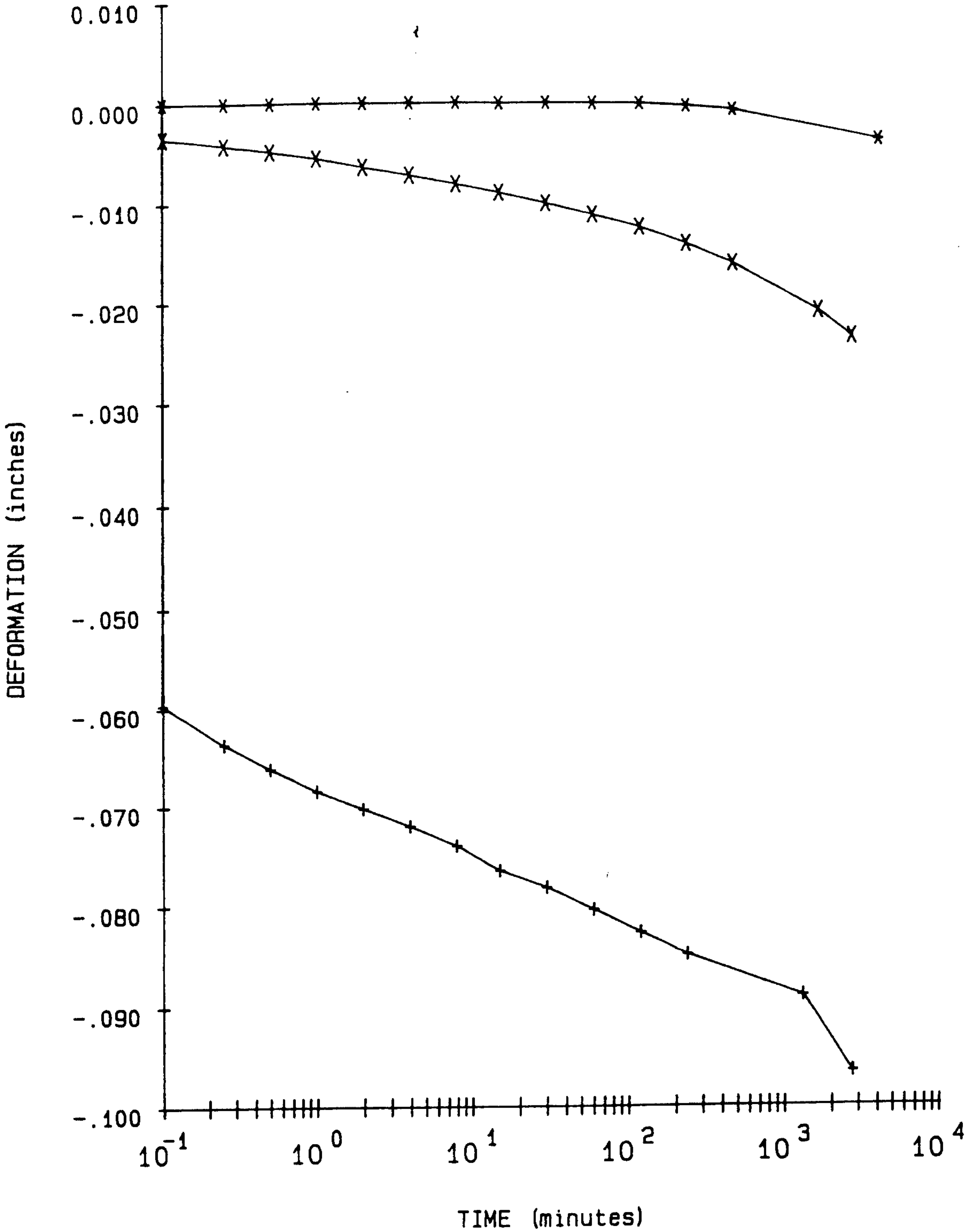
FIGURE D-186



Type of Specimen		Before Test		After Test	
Diam 2.5 in.	Ht .75 in.	Water Content, w_o	139.9 %	w_f	80.0 %
Overburden Pressure, p_o T/sq ft		Void Ratio, e_o	3.36	e_f	1.82
Preconsol. Pressure, p_c T/sq ft		Saturation, S_o	96 %	S_f	100 %
Compression Index, C_c		Dry Density, γ_d	32.9 lb/ft^3		
Classification Organic, OH		k_{20} at e_o = × 10^{-} cm/sec			
LL 157	G_s 2.3	Project CHASKA; CENCS-IA-91-45-ED-GH			
PL 84	D_{10}				
Remarks Brown-light brown, gray,		Area MRD LAB NO. 839			
Too soft for Torvane. Highly		Boring No. 90-143		Sample No. W-3	
calcareous organic.		Depth El 20'-22'		Date 3-27-91	
		CONSOLIDATION TEST REPORT			

ENG FORM 1 MAY 63 2090 PREVIOUS EDITIONS ARE OBSOLETE.

Figure 8

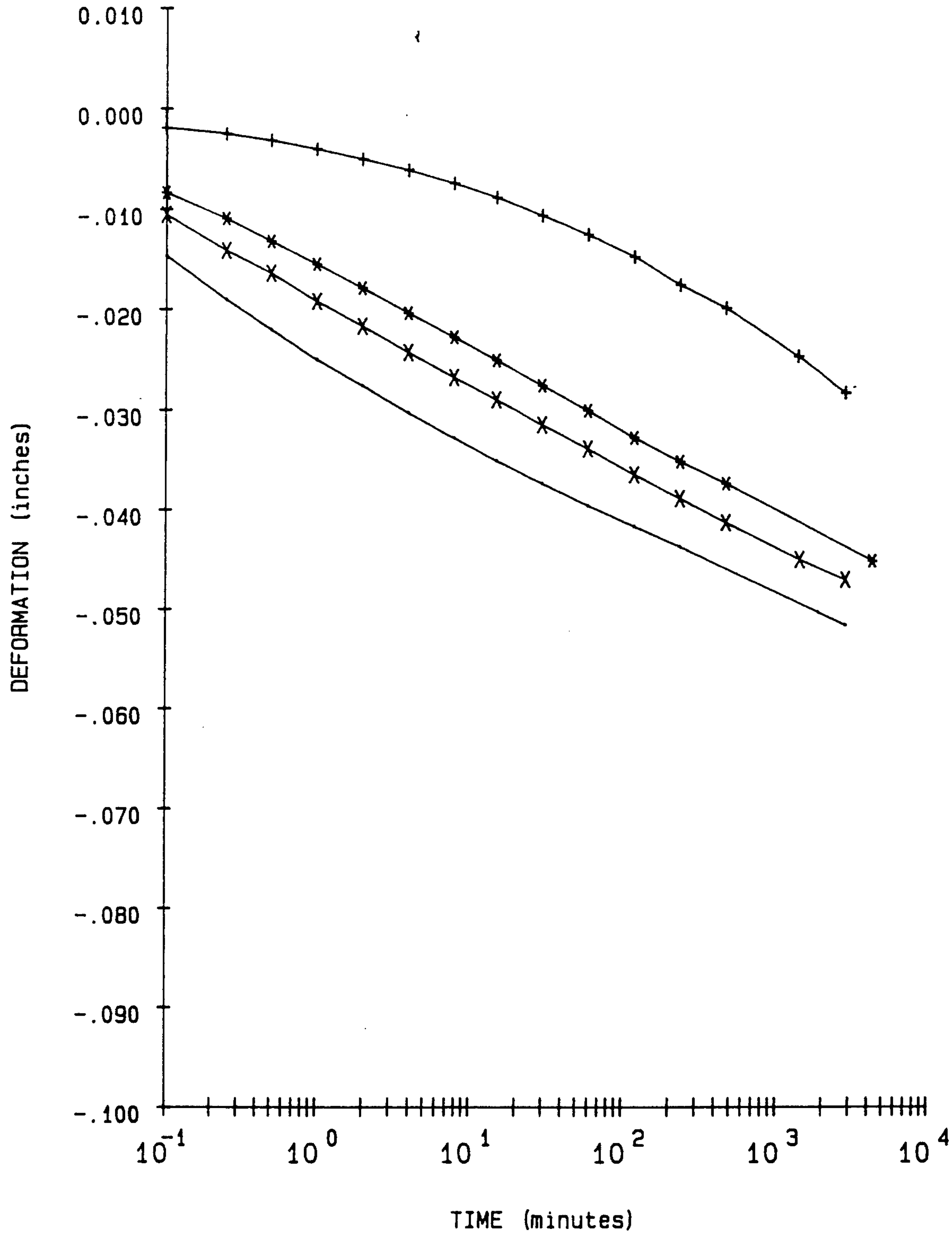


LEGEND
+ = .1 TSF
* = .25 TSF
X = .5 TSF

PROJECT	CHASKA: CENCS-IA-91-45-ED-GH
BORING NO.	90-143
SAMPLE NO.	W-3
DEPTH/ELEV	20'-22'
MRD LAB NO.	839

FIGURE 9

FIGURE D-188

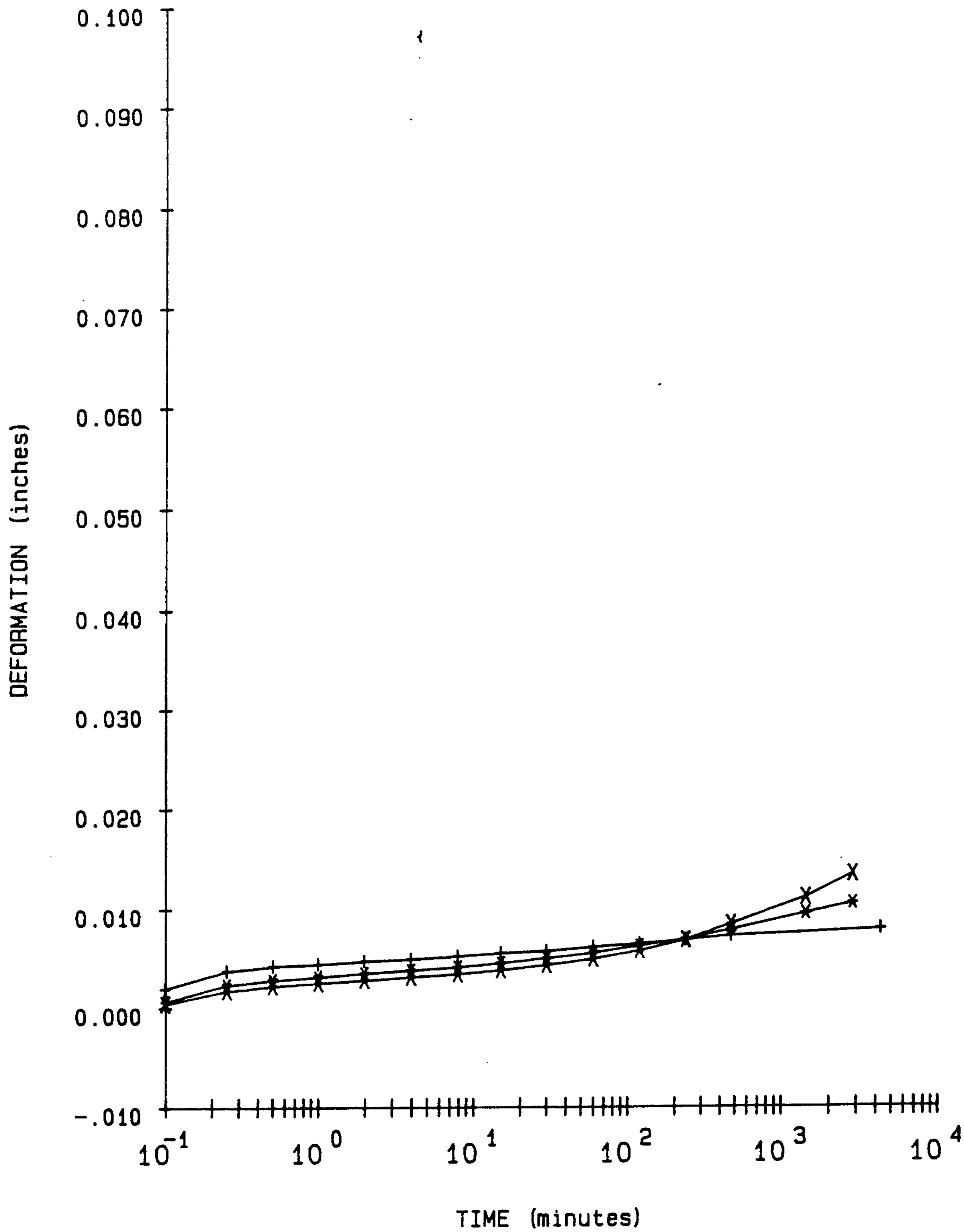


LEGEND	
+ = 1	TSF
* = 2	TSF
X = 4	TSF
- = 8	TSF

PROJECT	CHASKA: CENCS-IA-91-45-ED-GH
BORING NO.	90-143
SAMPLE NO.	W-3
DEPTH/ELEV	20'-22'
MRD LAB NO.	839

FIGURE 10

FIGURE D-189



LEGEND

+ = 2 TSF Rebound
* = .5 TSF Rebound
X = .1 TSF Rebound

PROJECT	CHASKA: CENCS-IA-91-45-ED-GH
BORING NO.	90-143
SAMPLE NO.	W-3
DEPTH/ELEV	20'-22'
MRD LAB NO.	839

FIGURE 11

FIGURE D-190

Consolidation Test Data

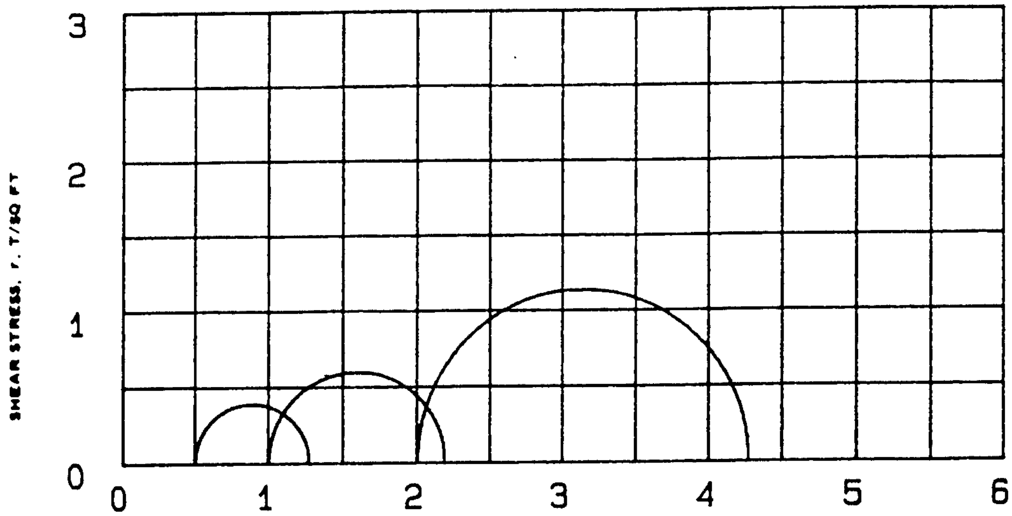
Project CHASKA; CENCS-IA-91-45-ED-GH

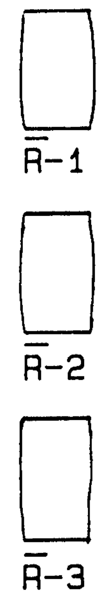
Boring No. 90-143
Sample No. W-3
Depth/Elev 20'-22'
MRD Lab No. 839

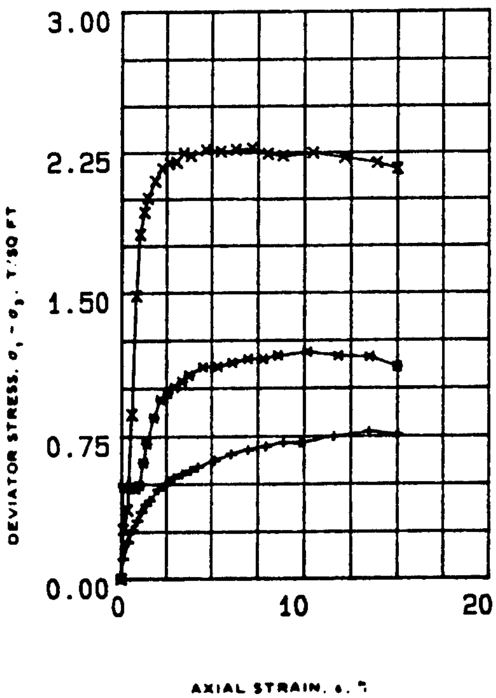
Gs = 2.7
eo = 4.118
0.42eo = 1.729

Water Content (%)	Dry Weight (gms)	Dry Density (PCF)	Void Ratio	Pressure (TSF)	Saturation (%)
139.9	31.7	32.9	4.118		91.7
80.0	31.7	37.8	3.458	0.10	62.5
80.0	31.7	38.0	3.430	0.25	63.0
80.0	31.7	39.5	3.269	0.50	66.1
80.0	31.7	41.3	3.075	1.00	70.2
80.0	31.7	44.7	2.767	2.00	78.1
80.0	31.7	48.9	2.445	4.00	88.3
80.0	31.7	54.5	2.092	8.00	100.0
80.0	31.7	53.5	2.146	2.00	100.0
80.0	31.7	52.4	2.218	0.50	97.4
80.0	31.7	50.9	2.309	0.10	93.5

Axial Strain (%)	Void Ratio
1	4.066
2	4.015
3	3.964
4	3.913
5	3.862
6	3.810
7	3.759
8	3.708
9	3.657
10	3.606
11	3.555
12	3.503
13	3.452
14	3.401
15	3.350
16	3.299
17	3.248
18	3.196
19	3.145
20	3.094







			1 (+)	2 (*)	3 (X)	
SPECIMEN NO.			1 (+)	2 (*)	3 (X)	
INITIAL	WATER CONTENT, %	w_o	154.3	121.5	104.2	
	DRY DENSITY LB/CU FT	γ_{d_o}	31.5	36.6	42.2	
	SATURATION, %	S_o	100	96	100	
	VOID RATIO	e_o	3.56	2.93	2.4	
BEFORE SHEAR	WATER CONTENT, %	w_c	76.5	110.2	83.1	
	DRY DENSITY LB/CU FT	γ_{d_c}	56	42.6	53.8	
	SATURATION, %	S_c	100	100	100	
	VOID RATIO	e_c	1.56	2.37	1.67	
	FINAL BACK PRESSURE, T/SQ FT	u_o	3.383	3.383	3.383	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.5	1	2	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	0.774	1.189	2.272	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	1200	1080	720	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	0.754	1.109	2.160	
INITIAL DIAMETER, IN.		D_o	1.38	1.38	1.38	
INITIAL HEIGHT, IN.		H_o	2.98	2.98	2.99	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Organic, OH B-Value 1.0 1.0 1.0

LL 157	PL 84	PI 73	Gs =2.3	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST RBAR

REMARKS: Brown-light, gray. Too soft for Torvane. Organic. Highly calcareous.

PROJECT CHASKA: CENCS-IA-91-45-ED-GH

BORING NO 90-143 SAMPLE NO. W-3

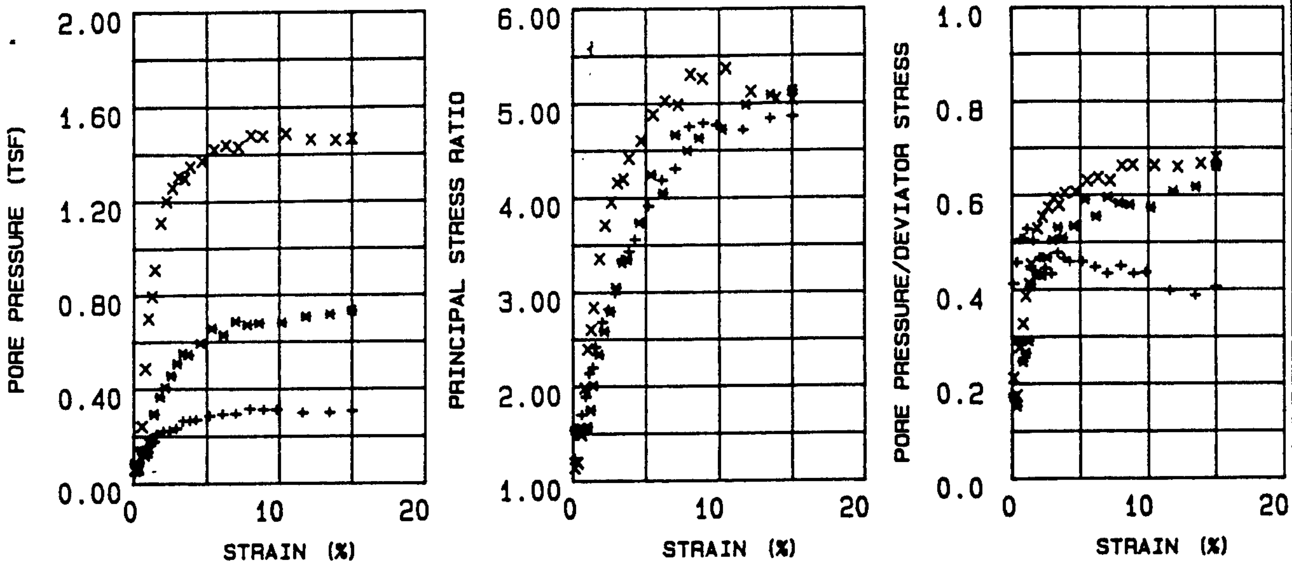
DEPTH ELEV 20'-22'

LABORATORY 839 DATE 04-19-91

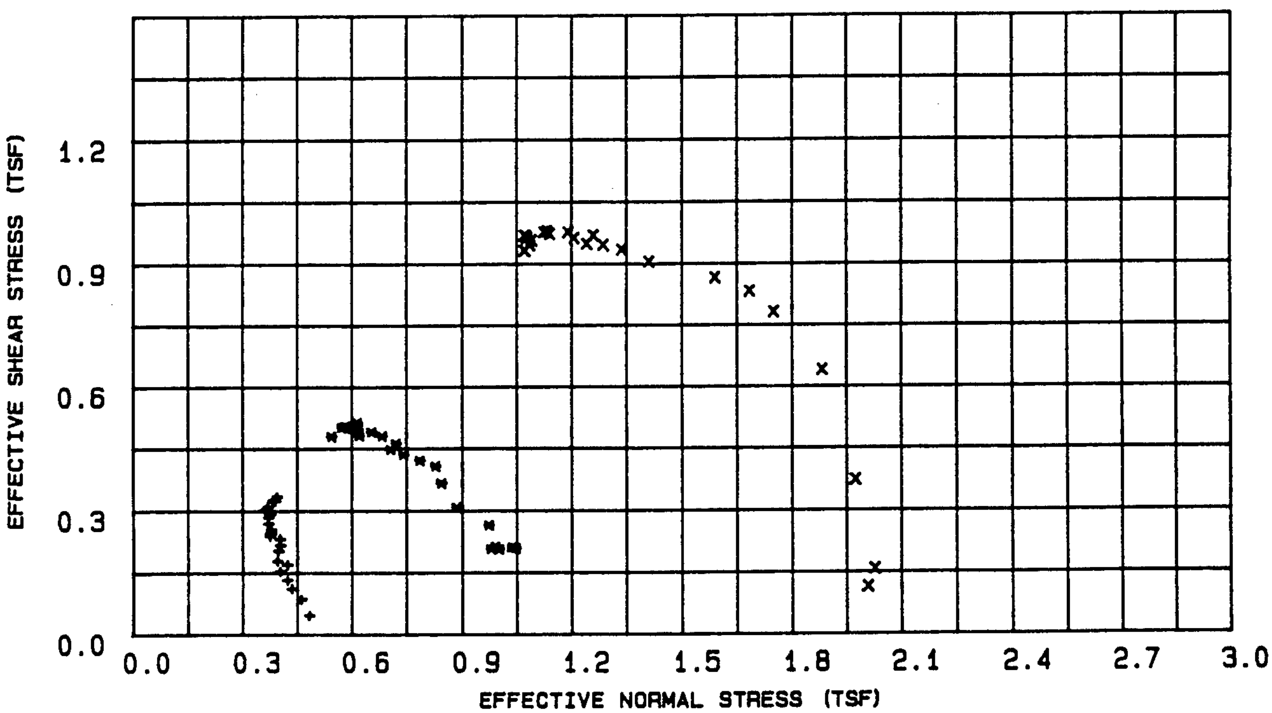
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)
REV JUNE 1970

Figure 12



EFFECTIVE STRESS VECTOR CURVES ON 60 DEGREE PLANE



LEGEND

+ = .5 TSF

* = 1 TSF

X = 2 TSF

PROJECT	CHASKA: CENCS-IA-91-45-ED-GH
BORING NO.	90-143
SAMPLE NO.	W-3
DEPTH/ELEV	20'-22'
MRD LAB NO.	839

FIGURE 13

FIGURE D-193

R

Table 7 - Triaxial $\bar{R}$ Test Results

Project : CHASKA; CENCS-IA-91-45-ED-GH
Boring Number : 90-143
Sample Number : W-3
Depth : 20'-22'
Confining Pressure : .5 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.14	0.107	0.044	1.236	0.412	0.483	0.046
30	0.40	0.196	0.089	1.477	0.457	0.460	0.085
45	0.65	0.258	0.130	1.697	0.506	0.434	0.111
60	0.91	0.307	0.155	1.889	0.507	0.421	0.132
90	1.14	0.355	0.187	2.137	0.528	0.401	0.153
120	1.39	0.391	0.175	2.200	0.447	0.422	0.169
150	1.59	0.414	0.208	2.416	0.503	0.394	0.178
180	2.05	0.471	0.220	2.682	0.467	0.397	0.203
210	2.47	0.503	0.223	2.817	0.444	0.402	0.217
240	2.93	0.535	0.231	2.985	0.432	0.401	0.231
300	3.38	0.553	0.264	3.343	0.478	0.373	0.239
360	3.84	0.571	0.265	3.430	0.465	0.376	0.246
420	4.26	0.589	0.269	3.555	0.458	0.377	0.254
480	5.17	0.624	0.286	3.911	0.458	0.369	0.269
540	6.08	0.658	0.293	4.182	0.446	0.370	0.284
600	6.99	0.680	0.294	4.302	0.433	0.374	0.293
720	7.96	0.699	0.314	4.750	0.449	0.359	0.302
840	8.90	0.718	0.310	4.787	0.432	0.368	0.310
960	9.80	0.714	0.310	4.764	0.435	0.367	0.308
1080	11.60	0.751	0.297	4.709	0.396	0.389	0.324
1200	13.47	0.774	0.298	4.838	0.386	0.394	0.334
1296	15.00	0.754	0.305	4.855	0.404	0.382	0.325
1296	15.00	0.754	0.305	4.855	0.404	0.382	0.325
1296	15.00	0.754	0.305	4.855	0.404	0.382	0.325

Table 8 - Triaxial $\overline{R}$ Test Results

Project : CHASKA; CENCS-IA-91-45-ED-GH
Boring Number : 90-143
Sample Number : W-3
Depth : 20'-22'
Confining Pressure : 1 TSF

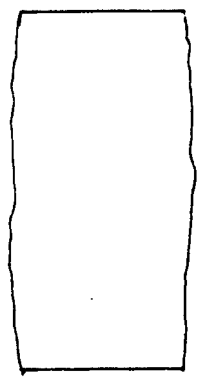
Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.12	0.488	0.083	1.532	0.171	1.038	0.211
30	0.35	0.484	0.073	1.522	0.152	1.047	0.209
45	0.57	0.481	0.139	1.558	0.291	0.980	0.207
60	0.80	0.477	0.117	1.540	0.246	1.001	0.206
90	1.00	0.494	0.131	1.569	0.265	0.991	0.213
120	1.22	0.614	0.179	1.747	0.291	0.973	0.265
150	1.40	0.713	0.292	2.008	0.410	0.885	0.308
180	1.80	0.849	0.366	2.338	0.431	0.844	0.366
210	2.17	0.943	0.405	2.584	0.430	0.828	0.407
240	2.57	0.975	0.456	2.792	0.468	0.785	0.421
300	2.97	1.007	0.508	3.048	0.505	0.741	0.435
360	3.37	1.039	0.551	3.313	0.531	0.706	0.448
420	3.74	1.070	0.544	3.348	0.509	0.721	0.462
480	4.54	1.112	0.593	3.735	0.534	0.682	0.480
540	5.34	1.114	0.656	4.240	0.590	0.620	0.481
600	6.14	1.134	0.627	4.044	0.554	0.654	0.490
720	6.99	1.153	0.685	4.662	0.595	0.600	0.498
840	7.81	1.153	0.670	4.491	0.582	0.615	0.497
960	8.61	1.171	0.677	4.623	0.578	0.613	0.506
1080	10.18	1.189	0.680	4.717	0.572	0.614	0.513
1200	11.83	1.167	0.707	4.986	0.607	0.582	0.504
1320	13.50	1.161	0.716	5.086	0.617	0.572	0.501
1420	15.00	1.109	0.731	5.129	0.660	0.544	0.479
1420	15.00	1.109	0.731	5.129	0.660	0.544	0.479

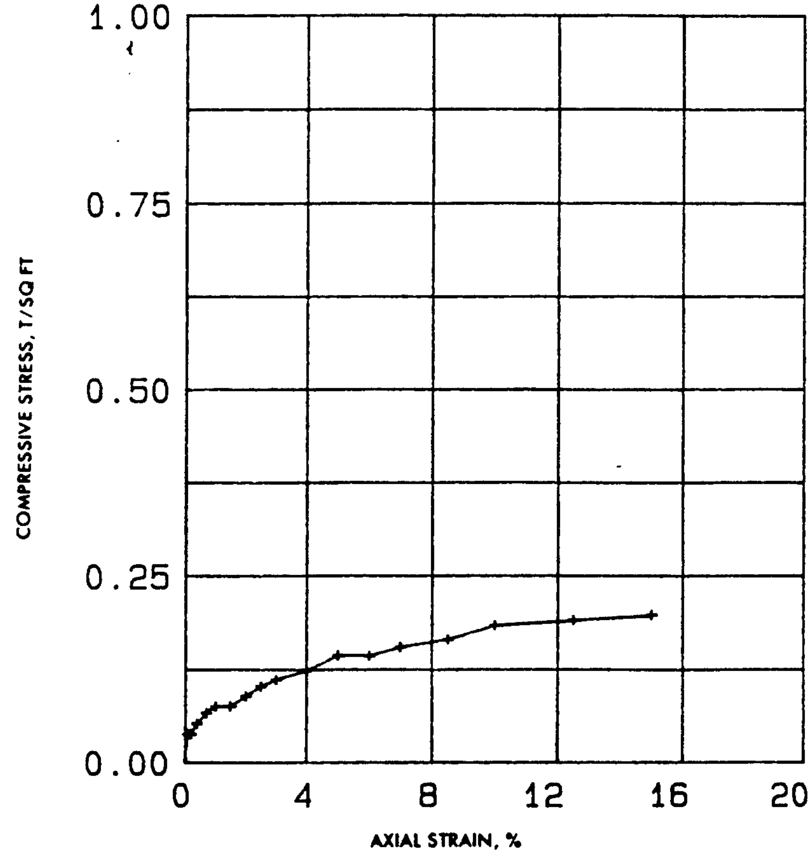
Table 9 - Triaxial $\bar{R}$ Test Results

Project : CHASKA; CENCS-IA-91-45-ED-GH
Boring Number : 90-143
Sample Number : W-3
Depth : 20'-22'
Confining Pressure : 2 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.13	0.263	0.056	1.135	0.212	2.009	0.114
30	0.36	0.365	0.063	1.188	0.174	2.027	0.157
45	0.59	0.863	0.240	1.490	0.278	1.974	0.372
60	0.82	1.484	0.484	1.979	0.327	1.883	0.640
90	1.03	1.811	0.699	2.392	0.386	1.749	0.782
120	1.26	1.929	0.795	2.600	0.412	1.683	0.833
150	1.44	2.006	0.908	2.836	0.453	1.589	0.866
180	1.85	2.096	1.109	3.351	0.529	1.410	0.905
210	2.23	2.166	1.200	3.706	0.554	1.336	0.935
240	2.64	2.193	1.257	3.951	0.574	1.286	0.946
300	3.05	2.199	1.303	4.156	0.593	1.241	0.949
360	3.46	2.246	1.297	4.195	0.578	1.259	0.969
420	3.85	2.232	1.347	4.416	0.604	1.206	0.963
480	4.67	2.264	1.371	4.601	0.606	1.189	0.977
540	5.49	2.254	1.419	4.881	0.630	1.139	0.973
600	6.31	2.264	1.438	5.027	0.636	1.123	0.977
720	7.18	2.272	1.430	4.986	0.630	1.132	0.980
840	8.03	2.241	1.480	5.305	0.661	1.075	0.967
960	8.85	2.230	1.476	5.259	0.663	1.076	0.962
1080	10.47	2.246	1.486	5.367	0.662	1.070	0.969
1200	12.16	2.220	1.461	5.119	0.659	1.089	0.958
1320	13.88	2.192	1.458	5.043	0.666	1.085	0.946
1392	15.00	2.160	1.464	5.033	0.679	1.070	0.932
1392	15.00	2.160	1.464	5.033	0.679	1.070	0.932

FAILURE SKETCHES





☐ CONTROLLED STRESS

☒ CONTROLLED STRAIN

TEST NO.						
TYPE OF SPECIMEN UNDISTURBED						
INITIAL	WATER CONTENT	w_o	154.7 %	%	%	%
	VOID RATIO	e_o	3.53			
	SATURATION	S_o	100 %	%	%	%
	DRY DENSITY, LB/CU FT	γ_d	31.7			
TIME TO FAILURE, MIN		t_f	23.5			
UNCONFINED COMPRESSIVE STRENGTH, T/SQ FT		q_u	0.20			
UNDRAINED SHEAR STRENGTH, T/SQ FT		s_u	0.10			
SENSITIVITY RATIO		S_t				
INITIAL SPECIMEN DIAMETER, IN		D_o	1.39			
INITIAL SPECIMEN HEIGHT, IN.		H_o	2.96			

CLASSIFICATION Organic, OH

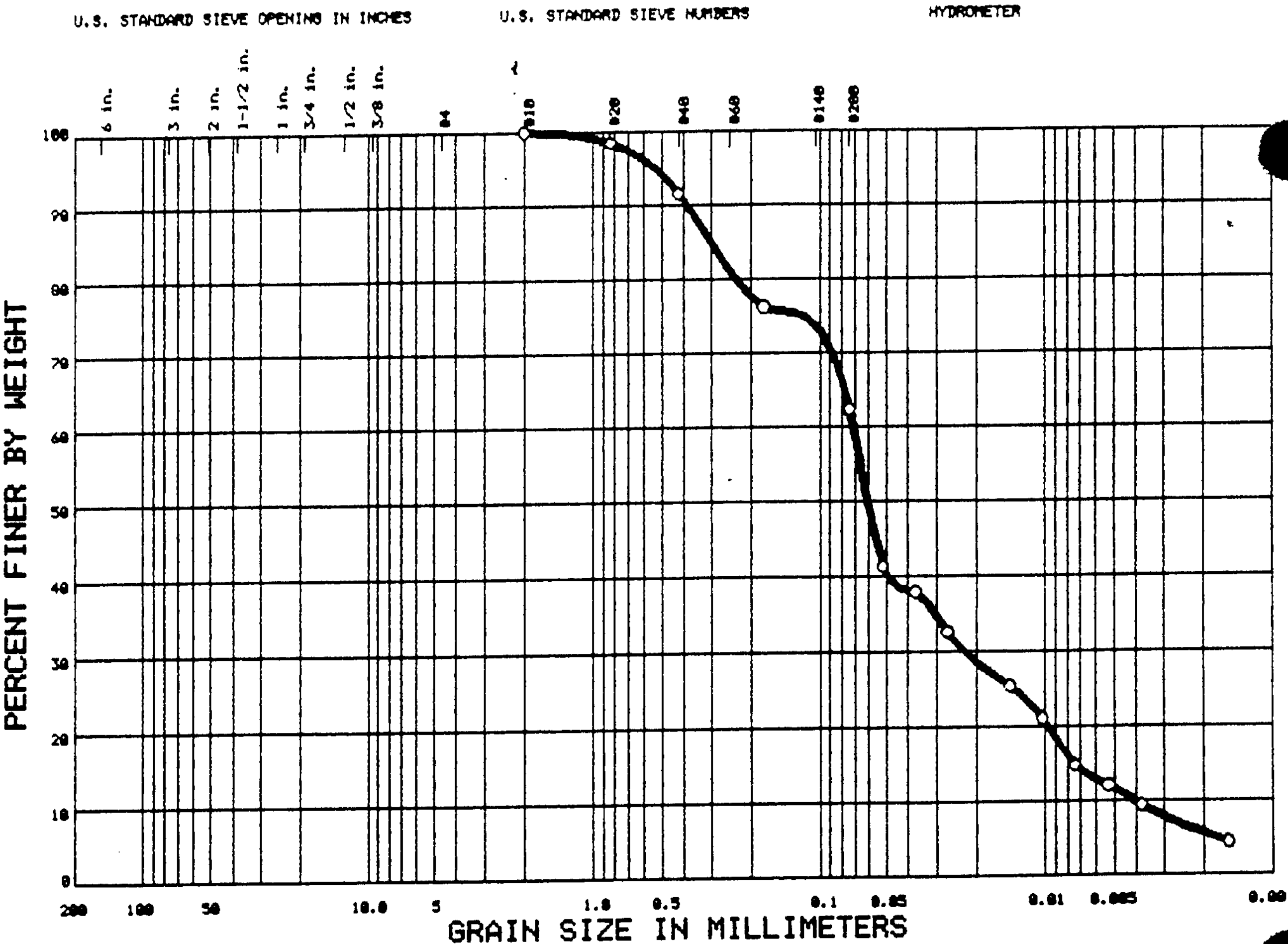
LL	PL	PI	G_s
157	84	73	2.3

REMARKS Brown-light brown, gray. Too soft for Torvane. Highly calcareous. Organic.

PROJECT	CHASKA; CENCS-IA-91-45-ED-GH		
AREA	MRD LAB NO. : 839		
BORING NO.	90-143	SAMPLE NO.	W-3
DEPTH EL	20'-22'	DATE	05-02-91

UNCONFINED COMPRESSION TEST REPORT

W.O. No.
Req. No.
Contract No.



	% COBBLES	% GRAVEL	% SAND	% SILT OR CLAY	
o	0.0	0.0	37.7	50.7	11.6

	Sample No.	Elev or Depth	Nat W%	LL	PL	PI	C_c	C_u
o	W-3	20' - 22'		156.9	84.1	72.8	1.75	17.6

CLASSIFICATION

o OH

Remarks:	Project CHASKA FLOOD CONTROL Lab No. 839 Area ST. PAUL DISTRICT Boring No. 90-143 Date 5-2-91

GRADATION CURVES

CORPS OF ENGINEERS, MISSOURI RIVER DIVISION LAB
420 SOUTH 18th STREET - OMAHA, NE 68102-2586

Figure 15

CLASSIFICATION TEST REQUEST

PROJECT: Chaska Flood Control Stage 3, East Creek

MRD LAB. NO.: 839

ACCOMPANYING TEST: Q, R, CON

REQUEST NO.: CENCS-IA-91-45-ED-GH

CONTAINER - TYPE: 3" TUBE

NO.:

SAMPLE IDENTIFICATION: 90-143 W-3 20.0'-22.0'

SAMPLE IDENTIFICATION:

Structure: (✓) Brittle ( ) Plastic ( )

Consistency: Undisturbed ( ) Soft (✓) Med ( ) Stiff ( ) Hard

Remolded (✓) Insensitive ( ) Sl. Sens. ( ) Sensitive

PL Thread: Strength (✓) Low ( ) Med ( ) High ( )

Shine (✓) None ( ) Dull ( ) Gloss ( ) H. Gloss ( )

Shake Test ( ) None ( ) Slow ( ) Fast ( ) Rapid ( )

Torvane: N/

Color: Brown-light brown & gray

Disturbance:

Est. Max. Particle Size:

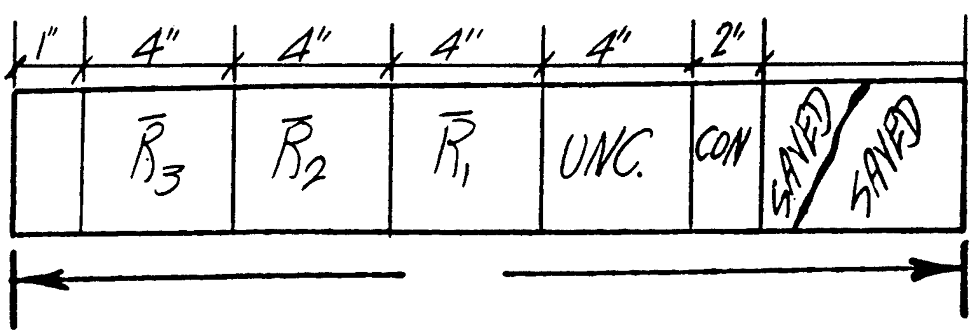
Remarks:

Odor: NONE, ORGANIC

Cementation: Highly Calcareous

Date Core Opened: 3-25-91

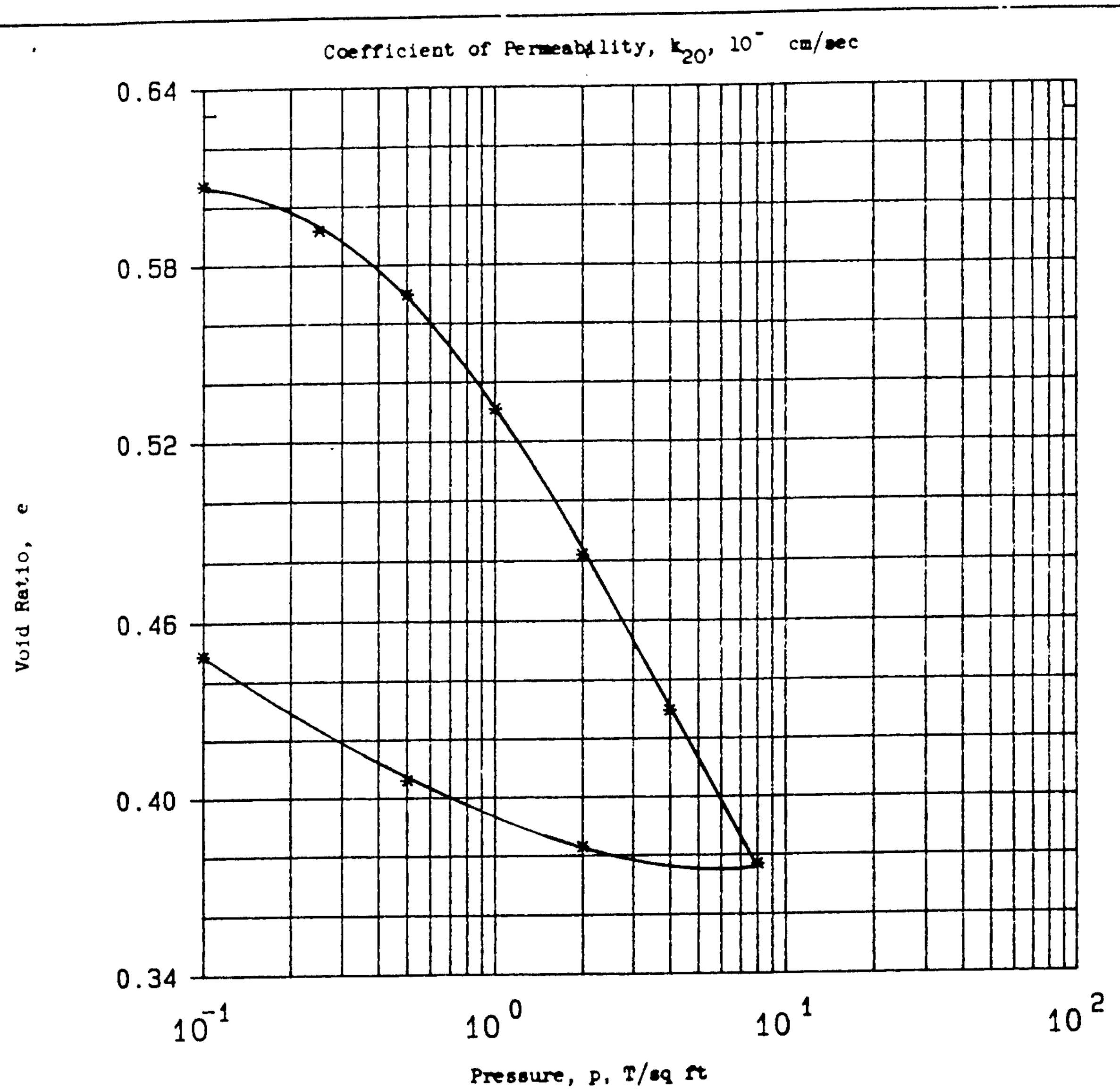
Sketch: (Core description and specimen location)



TOP

Technician ____________________

FIGURE D-199



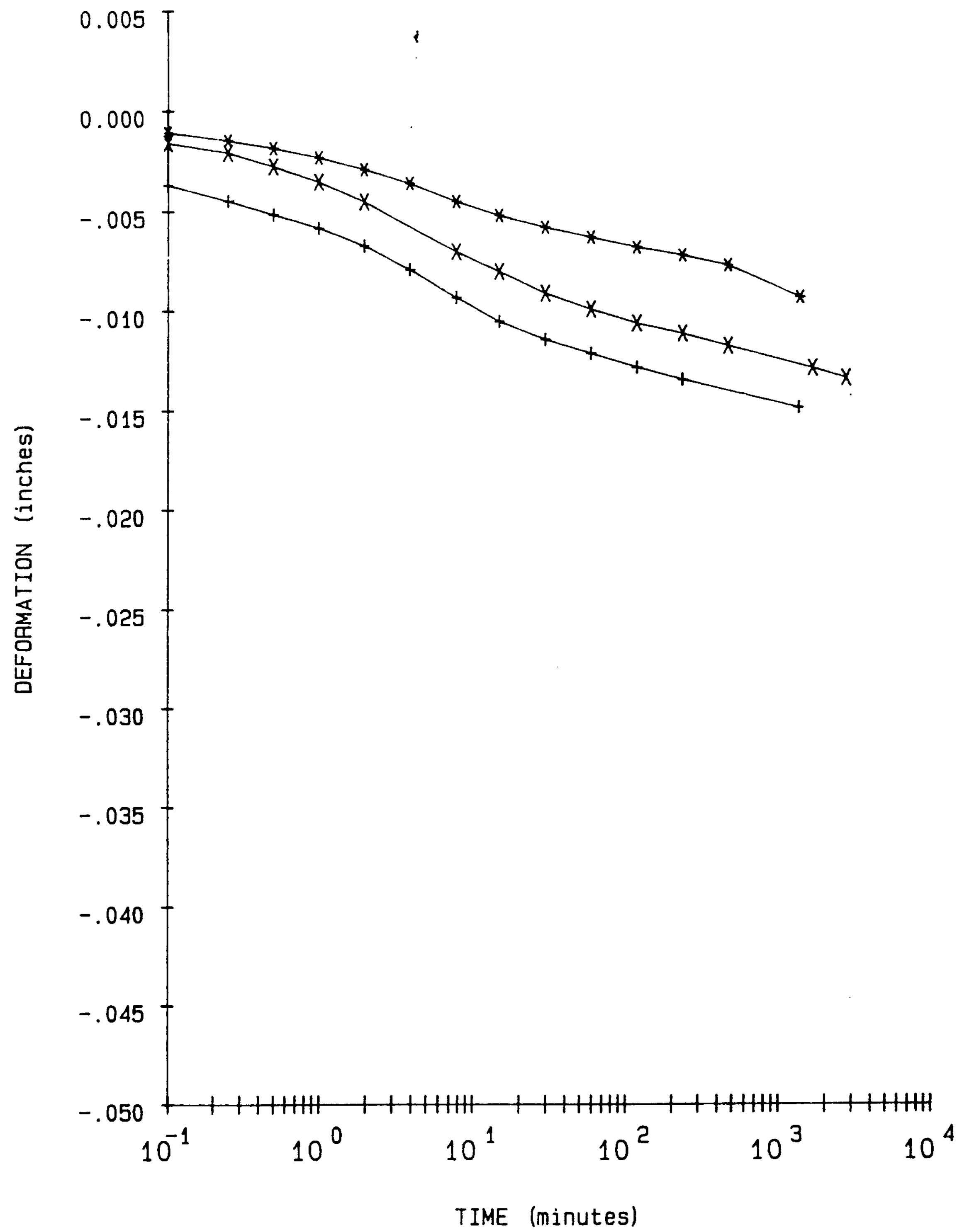
Type of Specimen UNDISTURBED		Before Test		After Test		
Diam 4.3 in.	Ht 1 in.	Water Content, w_o	21.5 %	w_f	18.9 %	
Overburden Pressure, Po T/sq ft		Void Ratio, e_o	0.63	e_f	0.45	
Preconsol. Pressure, Pc T/sq ft		Saturation, S_o	91 %	S_f	100 %	
Compression Index, C_c		Dry Density, γ_d	101.8 lb/ft^3			
Classification Clayey sand, SC		k_{20} at e_o = × 10^{-} cm/sec				
LL 50	G_s 2.66	Project	CHASKA; IA-91-45-ED-GH			
PL 18	D_{10}					
Remarks Dark gray. Too soft for		Area	MRD LAB NO. 839			
torvane.		Boring No.	91-144 M	Sample No.	W-4	
		Depth El	14.5'-17.2'	Date	03-28-91	

CONSOLIDATION TEST REPORT

ENG FORM 1 MAY 63 2090 PREVIOUS EDITIONS ARE OBSOLETE.

Figure 16

FIGURE D-200



LEGEND

+ = .1 TSF

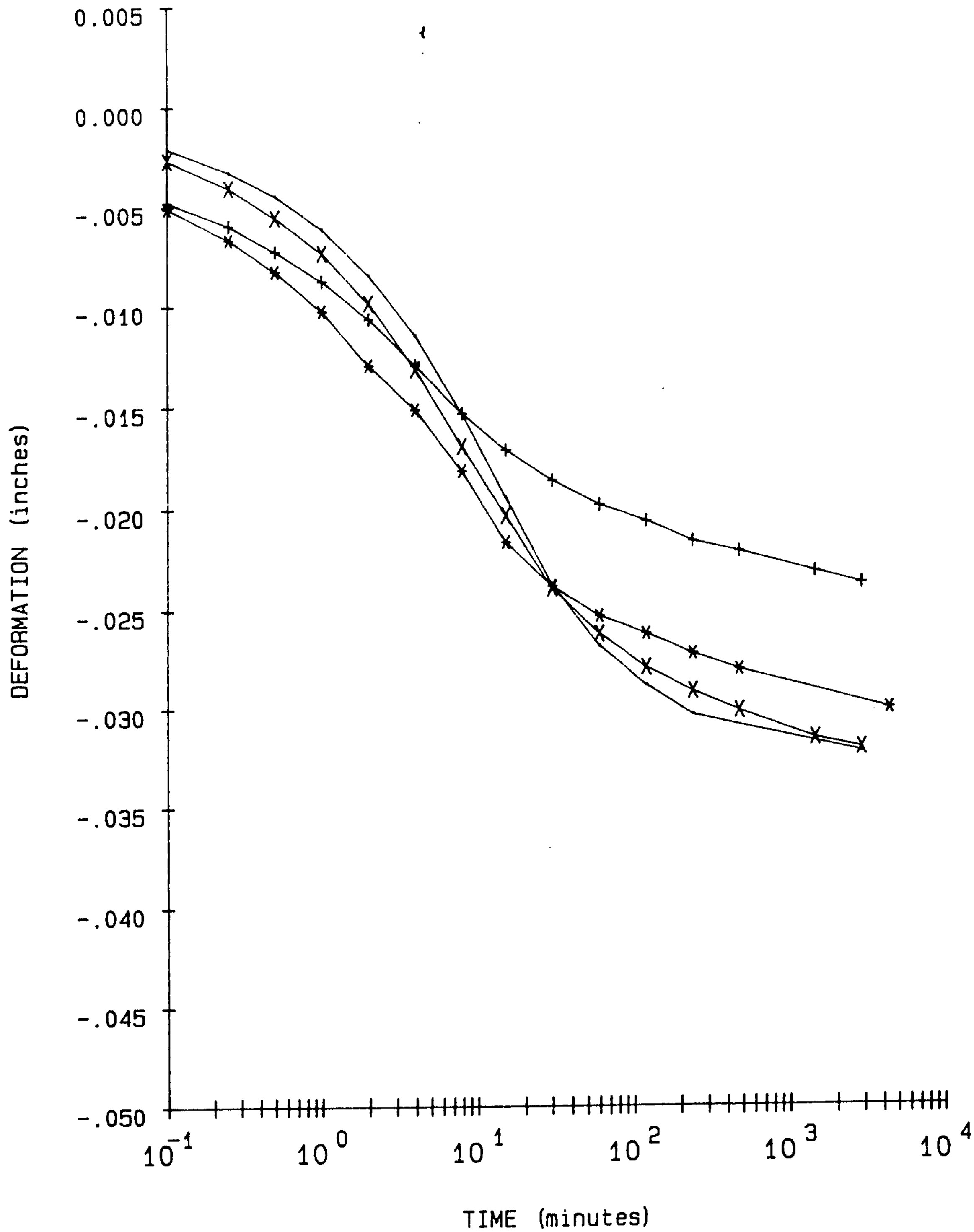
* = .25 TSF

X = .5 TSF

PROJECT	CHASKA: IA-91-45-ED-GH
BORING NO.	91-144 M
SAMPLE NO.	W-4
DEPTH/ELEV	14.5'-17.2'
MRD LAB NO.	839

FIGURE 17

FIGURE D-201

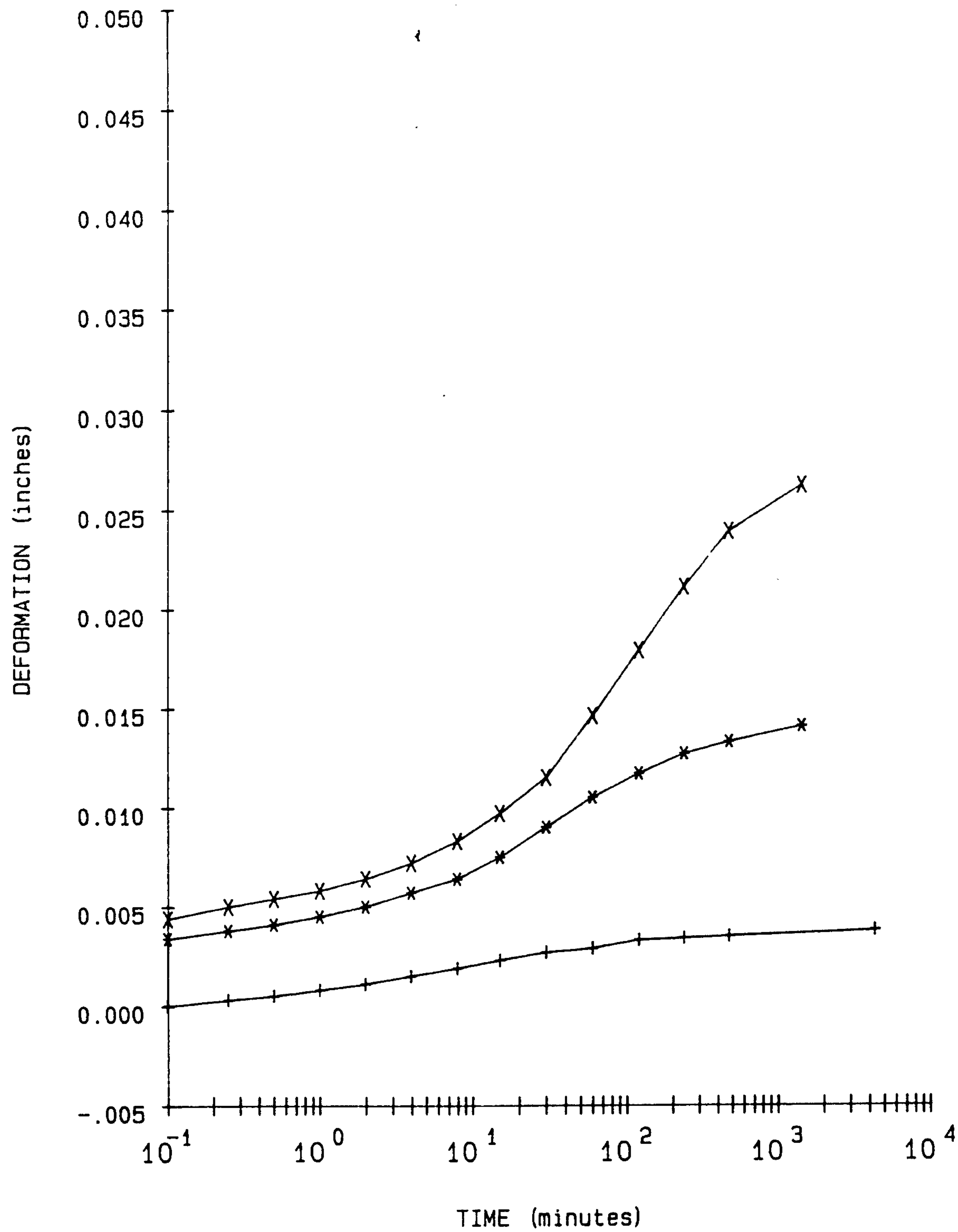


LEGEND	
+ = 1	TSF
* = 2	TSF
X = 4	TSF
- = 8	TSF

PROJECT	CHASKA: IA-91-45-ED-GH
BORING NO.	91-144 M
SAMPLE NO.	W-4
DEPTH/ELEV	14.5'-17.2'
MRD LAB NO.	839

FIGURE 18

FIGURE D-202



LEGEND

+ = 2 TSF Rebound
* = .5 TSF Rebound
X = .1 TSF Rebound

PROJECT	CHASKA; IA-91-45-ED-GH
BORING NO.	91-144 M
SAMPLE NO.	W-4
DEPTH/ELEV	14.5'-17.2'
MRD LAB NO.	839

FIGURE 19

Consolidation Test Data

Project CHASKA; IA-91-45-ED-GH

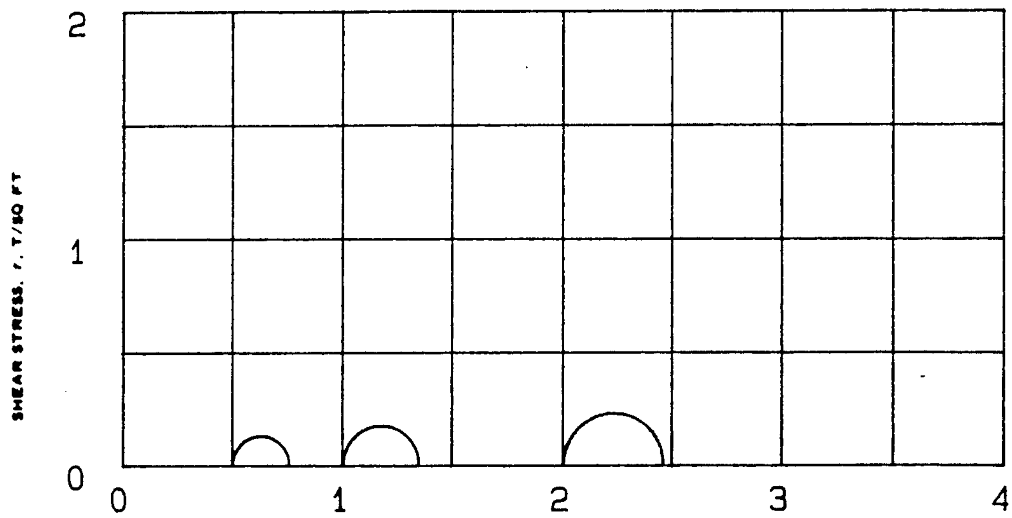
Boring No. 91-144 M
Sample No. W-4
Depth/Elev 14.5'-17.2'
MRD Lab No. 839

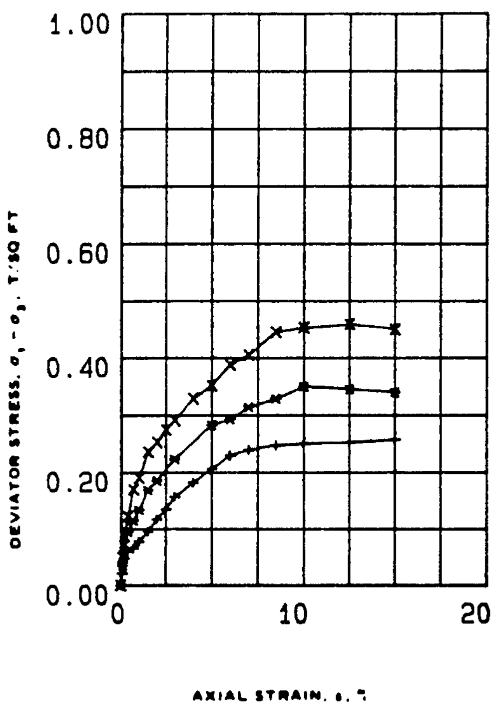
Gs = 2.66
eo = 0.631
0.42eo = 0.265

Water Content (%)	Dry Weight (gms)	Dry Density (PCF)	Void Ratio	Pressure (TSF)	Saturation (%)
21.5	382.5	101.8	0.631		90.7
18.9	382.5	103.3	0.607	0.10	82.8
18.9	382.5	104.3	0.592	0.25	85.0
18.9	382.5	105.7	0.570	0.50	88.2
18.9	382.5	108.4	0.531	1.00	94.7
18.9	382.5	112.0	0.482	2.00	100.0
18.9	382.5	116.1	0.429	4.00	100.0
18.9	382.5	120.6	0.377	8.00	100.0
18.9	382.5	120.0	0.383	2.00	100.0
18.9	382.5	118.1	0.406	0.50	100.0
18.9	382.5	114.6	0.449	0.10	100.0

Axial Strain (%)	Void Ratio
1	0.615
2	0.599
3	0.582
4	0.566
5	0.550
6	0.533
7	0.517
8	0.501
9	0.484
10	0.468
11	0.452
12	0.436
13	0.419
14	0.403
15	0.387
16	0.370
17	0.354
18	0.338

FIGURE D-204





SPECIMEN NO.			1 (+)	2 (*)	3 (X)	
INITIAL	WATER CONTENT, %	w_o	33.4	33.3	35.0	
	DRY DENSITY LB/CU FT	γd_o	85.3	85.7	86.1	
	SATURATION, %	S_o	94.0	94.0	100.0	
	VOID RATIO	e_o	0.95	0.94	0.93	
BEFORE SHEAR	WATER CONTENT, %	w_c	39.3	36.7	35.0	
	DRY DENSITY LB/CU FT	γd_c	85.7	86.0	86.2	
	SATURATION, %	S_c	100.0	100.0	100.0	
	VOID RATIO	e_c	0.94	0.93	0.93	
	FINAL BACK PRESSURE, T/SQ FT	u_o	0.0	0.0	0.0	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	0.5	1.0	2.0	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	0.26	0.35	0.46	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	24.5	27.0	17.5	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	0.26	0.34	0.45	
INITIAL DIAMETER, IN.		D_o	1.41	1.42	1.40	
INITIAL HEIGHT, IN.		H_o	3.00	3.00	3.00	

CONTROLLED-STRAIN TEST

DESCRIPTION OF SPECIMENS Clayey sand, SC

LL 50 | PL 18 | PI 32 | G_s 2.66

TYPE OF SPECIMEN UNDISTURBED | TYPE OF TEST Q

REMARKS: Dark gray. Too soft for Torvane.

PROJECT CHASKA; CENCS-IA-91-45-ED-GH

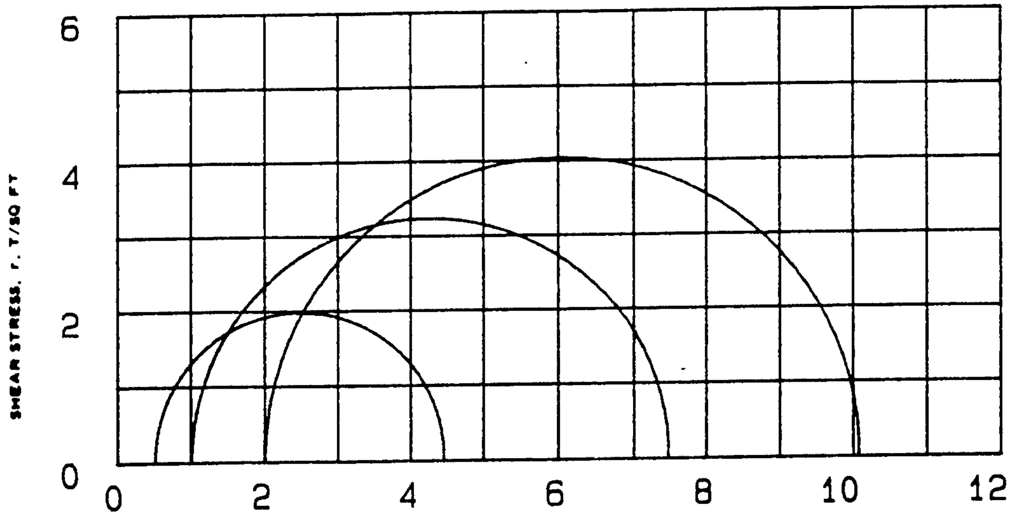
BORING NO 91-144MU | SAMPLE NO. W-4

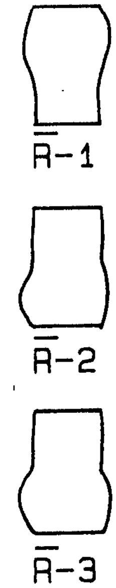
DEPTH ELEV 14.5'-17.2'

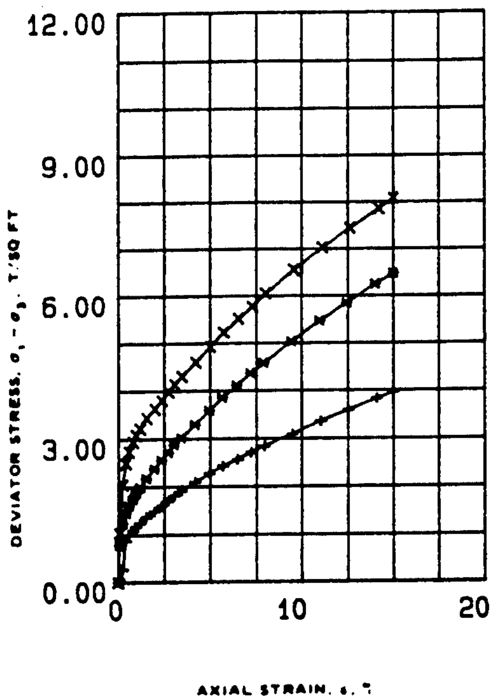
LABORATORY 839 | DATE 03-29-91

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT *(EM 1110-2-1906)* FIGURE 20







			1 (+)	2 (*)	3 (X)
SPECIMEN NO.			1 (+)	2 (*)	3 (X)
INITIAL	WATER CONTENT, %	w_o	20.9	19.4	20.4
INITIAL	DRY DENSITY LB/CU FT	γd_o	108.8	108.7	107.6
INITIAL	SATURATION, %	S_o	100	98	100
INITIAL	VOID RATIO	e_o	.53	.53	.54
BEFORE SHEAR	WATER CONTENT, %	w_c	19.6	19	19.3
BEFORE SHEAR	DRY DENSITY LB/CU FT	γd_c	109.2	111	109.6
BEFORE SHEAR	SATURATION, %	S_c	100	100	100
BEFORE SHEAR	VOID RATIO	e_c	.52	.5	.52
BEFORE SHEAR	FINAL BACK PRESSURE, T/SQ FT	u_o	4.103	4.103	4.103
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.5	1	2
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	3.963	6.475	8.079
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	1512	1519	1504
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	3.963	6.475	8.079
INITIAL DIAMETER, IN.		D_o	1.37	1.37	1.38
INITIAL HEIGHT, IN.		H_o	2.97	3.01	2.96

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Clayey sand, SC B-Value 1.0 1.0 1.0

LL 50 | PL 18 | PI 32 | G_s 2.66

TYPE OF SPECIMEN UNDISTURBED | TYPE OF TEST RBAR

REMARKS: Dark gray. Too soft for Torvane.

PROJECT CHASKA: CENCS-IA-91-45-ED-6H

BORING NO 91-144M | SAMPLE NO. W-4

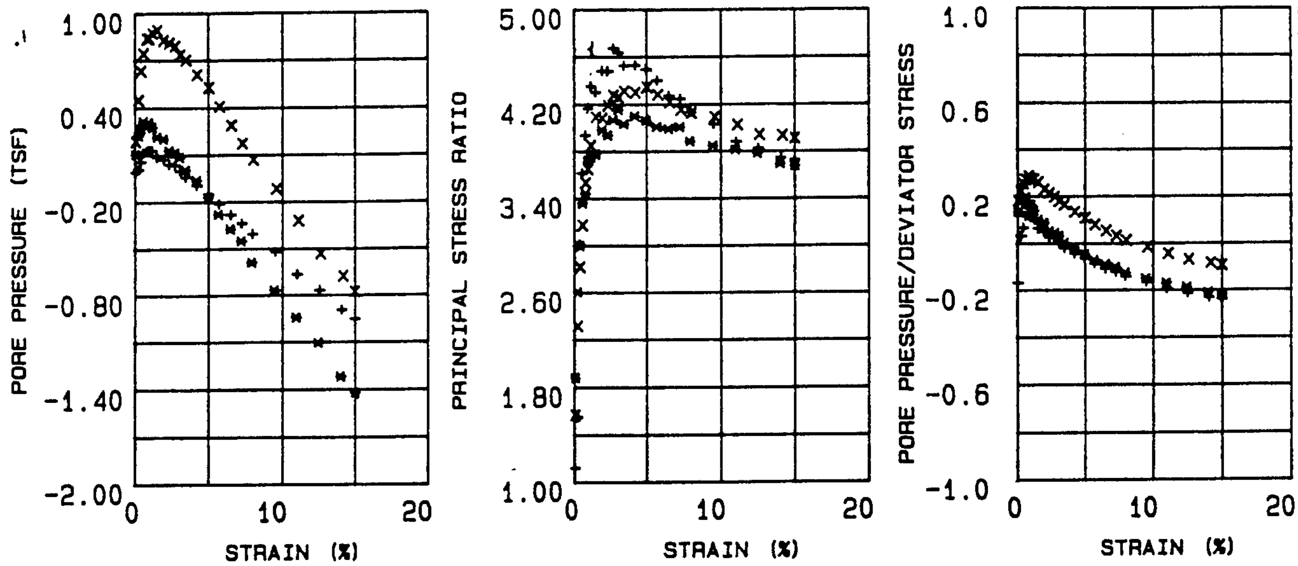
DEPTH ELEV 14.5'-17.2'

LABORATORY 839 | DATE 03-28-91

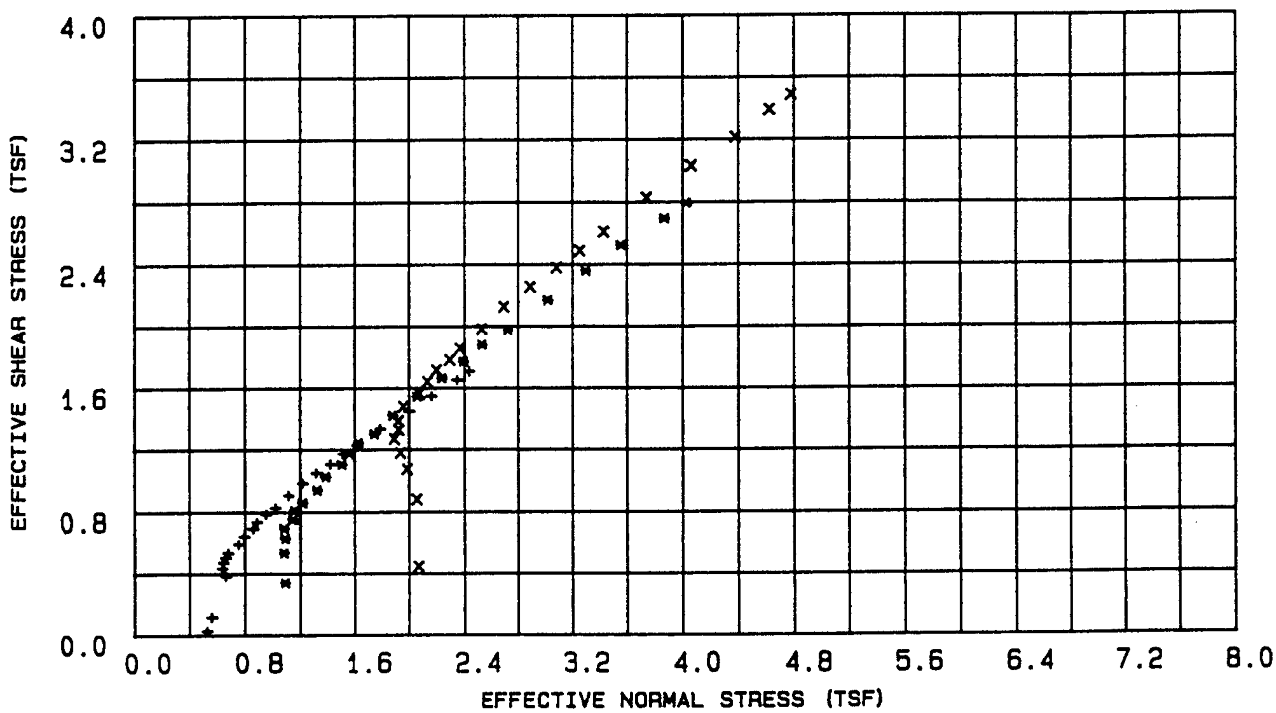
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT *(EM 1110-2-1906)*

FIGURE 21



EFFECTIVE STRESS VECTOR CURVES ON 60 DEGREE PLANE



LEGEND

+ = .5 TSF

✱ = 1 TSF

X = 2 TSF

PROJECT	CHASKA; CENCS-IA-91-45-ED-GH
BORING NO.	91-144M
SAMPLE NO.	W-4
DEPTH/ELEV	14.5'-17.2'
MRD LAB NO.	839

FIGURE 22

R

Table 10 - Triaxial $\bar{R}$ Test Results

Project : CHASKA; CENCS-IA-91-45-ED-GH
Boring Number : 91-144M
Sample Number : W-4
Depth : 14.5'-17.2'
Confining Pressure : .5 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.07	0.060	-0.010	1.118	-0.169	0.525	0.026
30	0.27	0.271	0.008	1.552	0.031	0.559	0.117
45	0.43	0.888	0.058	3.011	0.066	0.662	0.383
60	0.60	1.005	0.116	3.615	0.116	0.633	0.434
90	0.82	1.093	0.128	3.938	0.118	0.643	0.472
120	0.99	1.172	0.130	4.168	0.111	0.660	0.506
150	1.20	1.241	0.130	4.354	0.105	0.677	0.536
180	1.54	1.371	0.085	4.303	0.062	0.754	0.592
210	1.98	1.488	0.073	4.483	0.049	0.795	0.642
240	2.36	1.606	0.039	4.482	0.025	0.859	0.693
300	2.74	1.704	0.036	4.672	0.022	0.886	0.736
360	3.08	1.821	-0.001	4.635	0.000	0.952	0.786
420	3.47	1.918	-0.044	4.525	-0.022	1.019	0.828
480	4.21	2.101	-0.095	4.529	-0.045	1.115	0.907
540	4.98	2.279	-0.153	4.493	-0.066	1.217	0.984
600	5.71	2.430	-0.215	4.399	-0.088	1.317	1.049
720	6.50	2.567	-0.285	4.272	-0.110	1.421	1.108
840	7.25	2.721	-0.339	4.244	-0.124	1.513	1.174
960	7.97	2.847	-0.408	4.134	-0.143	1.613	1.229
1080	9.51	3.095	-0.522	4.028	-0.168	1.788	1.336
1200	11.02	3.359	-0.667	3.878	-0.198	1.999	1.450
1320	12.52	3.589	-0.772	3.822	-0.215	2.161	1.549
1440	14.08	3.829	-0.897	3.741	-0.234	2.345	1.652
1512	15.00	3.963	-0.956	3.723	-0.241	2.437	1.711

Table 11 - Triaxial $\bar{R}$ Test Results

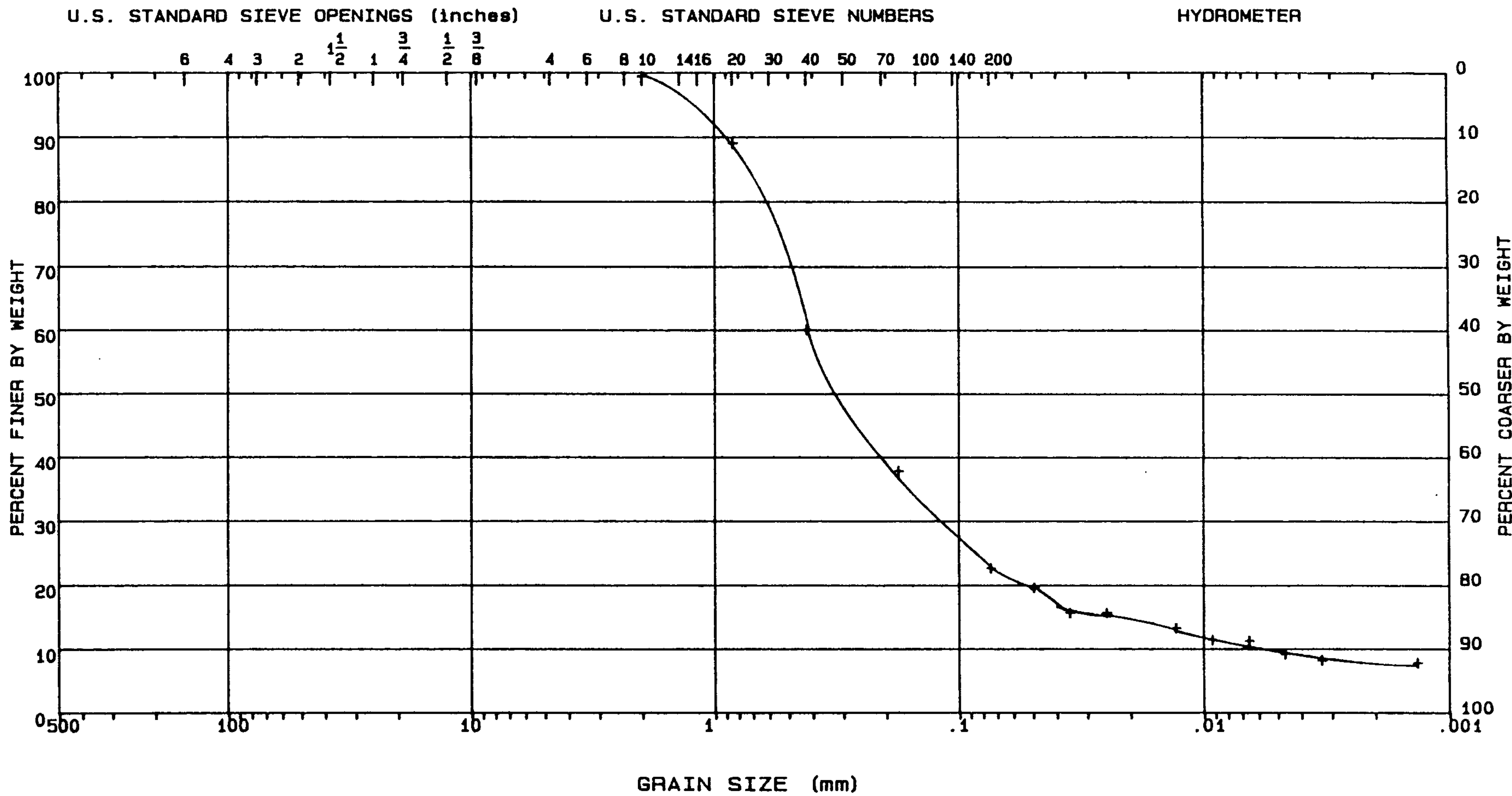
Project : CHASKA; CENCS-IA-91-45-ED-GH
Boring Number : 91-144M
Sample Number : W-4
Depth : 14.5'-17.2'
Confining Pressure : 1 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.07	0.788	0.105	1.881	0.134	1.090	0.340
30	0.26	1.243	0.226	2.605	0.182	1.082	0.536
45	0.43	1.458	0.270	2.997	0.186	1.091	0.629
60	0.60	1.612	0.316	3.358	0.197	1.083	0.696
90	0.81	1.745	0.285	3.441	0.164	1.147	0.753
120	0.98	1.879	0.307	3.712	0.164	1.158	0.811
150	1.20	1.991	0.276	3.751	0.139	1.217	0.859
180	1.53	2.178	0.215	3.775	0.099	1.324	0.940
210	1.96	2.379	0.202	3.981	0.085	1.387	1.027
240	2.35	2.561	0.128	3.936	0.050	1.506	1.105
300	2.73	2.722	0.113	4.068	0.042	1.561	1.175
360	3.06	2.883	0.086	4.155	0.030	1.628	1.245
420	3.45	3.022	0.003	4.031	0.001	1.745	1.304
480	4.19	3.298	-0.064	4.100	-0.019	1.880	1.423
540	4.96	3.586	-0.172	4.059	-0.048	2.060	1.548
600	5.67	3.853	-0.282	4.006	-0.073	2.236	1.663
720	6.46	4.112	-0.376	3.989	-0.091	2.394	1.775
840	7.21	4.368	-0.453	4.007	-0.103	2.534	1.885
960	7.92	4.584	-0.591	3.882	-0.128	2.726	1.979
1080	9.45	5.035	-0.770	3.844	-0.153	3.016	2.173
1200	10.96	5.468	-0.946	3.811	-0.172	3.300	2.360
1320	12.45	5.851	-1.107	3.777	-0.189	3.556	2.525
1440	14.00	6.246	-1.323	3.689	-0.211	3.869	2.696
1519	15.00	6.475	-1.424	3.671	-0.220	4.027	2.794

Table 12 - Triaxial $\bar{R}$ Test Results

Project : CHASKA; CENCS-IA-91-45-ED-GH
Boring Number : 91-144M
Sample Number : W-4
Depth : 14.5'-17.2'
Confining Pressure : 2 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.07	1.031	0.187	1.568	0.182	2.068	0.445
30	0.27	2.040	0.449	2.315	0.221	2.056	0.880
45	0.44	2.486	0.632	2.818	0.255	1.984	1.073
60	0.61	2.733	0.742	3.173	0.272	1.935	1.179
90	0.83	2.941	0.838	3.531	0.286	1.890	1.269
120	0.99	3.078	0.838	3.649	0.273	1.924	1.328
150	1.21	3.212	0.872	3.849	0.272	1.923	1.386
180	1.55	3.430	0.891	4.093	0.260	1.958	1.480
210	1.99	3.624	0.824	4.082	0.228	2.073	1.564
240	2.38	3.801	0.809	4.191	0.213	2.132	1.640
300	2.76	3.976	0.787	4.277	0.198	2.197	1.716
360	3.10	4.134	0.732	4.260	0.178	2.292	1.784
420	3.49	4.306	0.699	4.311	0.163	2.367	1.859
480	4.24	4.596	0.607	4.299	0.133	2.531	1.984
540	5.02	4.930	0.526	4.345	0.107	2.695	2.128
600	5.75	5.227	0.406	4.280	0.078	2.888	2.256
720	6.55	5.514	0.286	4.217	0.052	3.079	2.380
840	7.30	5.765	0.170	4.150	0.030	3.257	2.488
960	8.03	6.046	0.065	4.125	0.011	3.432	2.610
1080	9.58	6.552	-0.120	4.091	-0.018	3.742	2.828
1200	11.11	7.023	-0.324	4.022	-0.046	4.063	3.031
1320	12.61	7.443	-0.535	3.937	-0.071	4.378	3.213
1440	14.19	7.853	-0.680	3.930	-0.086	4.624	3.390
1503	15.00	8.079	-0.781	3.906	-0.096	4.781	3.487



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

LL = 50	PL = 18	PI = 32	Gs = 2.66	NAT w = %

CLASSIFICATION Clayey sand, SC

PROJECT	CHASKA; CENCS-IA-91-45-ED-GH
DATE	03-20-91
BORING NO.	91-144MU
SAMPLE NO.	W-4
DEPTH/ELEV	14.5'-17.2'
MRD LAB NO.	839

GRADATION CURVE

FIGURE 23

FIGURE D-211

CLASSIFICATION TEST REQUEST

PROJECT: Chaska Flood Control Stage 3, East Creek

MRD LAB. NO.: 839

ACCOMPANYING TEST: Q, R, CON

REQUEST NO.: CENCS-IA-91-45-ED-G

CONTAINER - TYPE: 5" TUBE

NO.:

SAMPLE IDENTIFICATION: 91-144M W-4 14.5'-17.2

SAMPLE IDENTIFICATION:

Structure: (✓) Brittle ( ) Plastic ( )

Consistency: Undisturbed (✓) Soft ( ) Med ( ) Stiff ( ) Hard

Remolded ( ) Insensitive ( ) Sl. Sens. ( ) Sensitive

PL Thread: Strength (✓) Low ( ) Med ( ) High ( )

Shine ( ) None (✓) Dull ( ) Gloss ( ) H. Gloss ( )

Shake Test (✓) None ( ) Slow ( ) Fast ( ) Rapid ( )

Torvane: N/A

Color: Dark Gray

Disturbance: None

Est. Max. Particle Size:

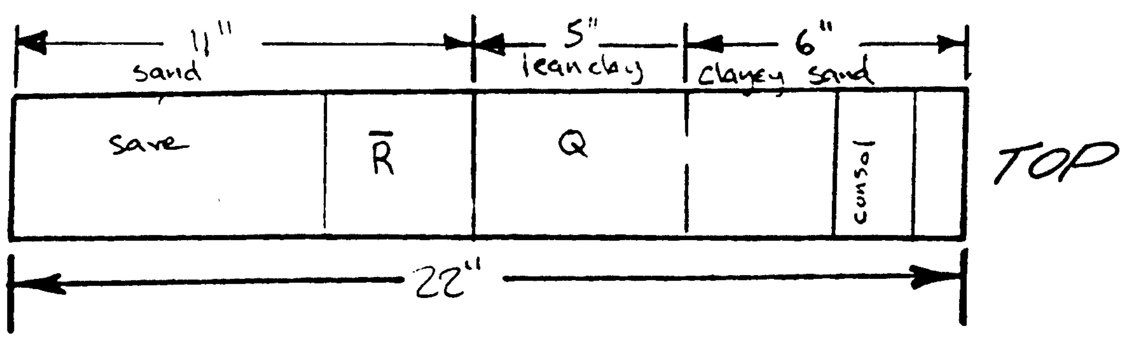
Remarks:

Odor: None

Cementation: None

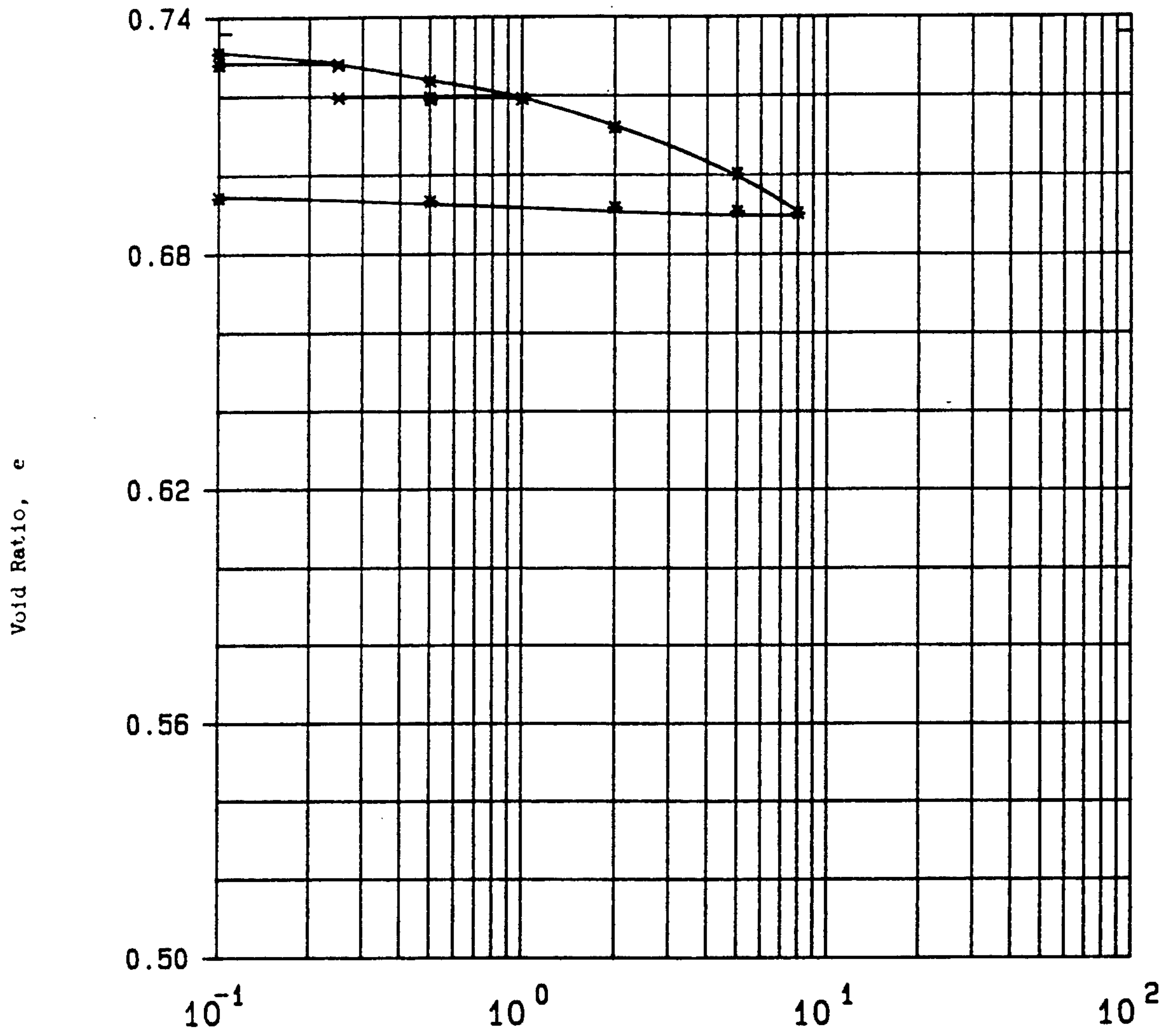
Date Core Opened: 3/20/91

Sketch: (Core description and specimen location)



Technician Mike Wolkerman

Coefficient of Permeability, k_{20}, 10^{-} cm/sec

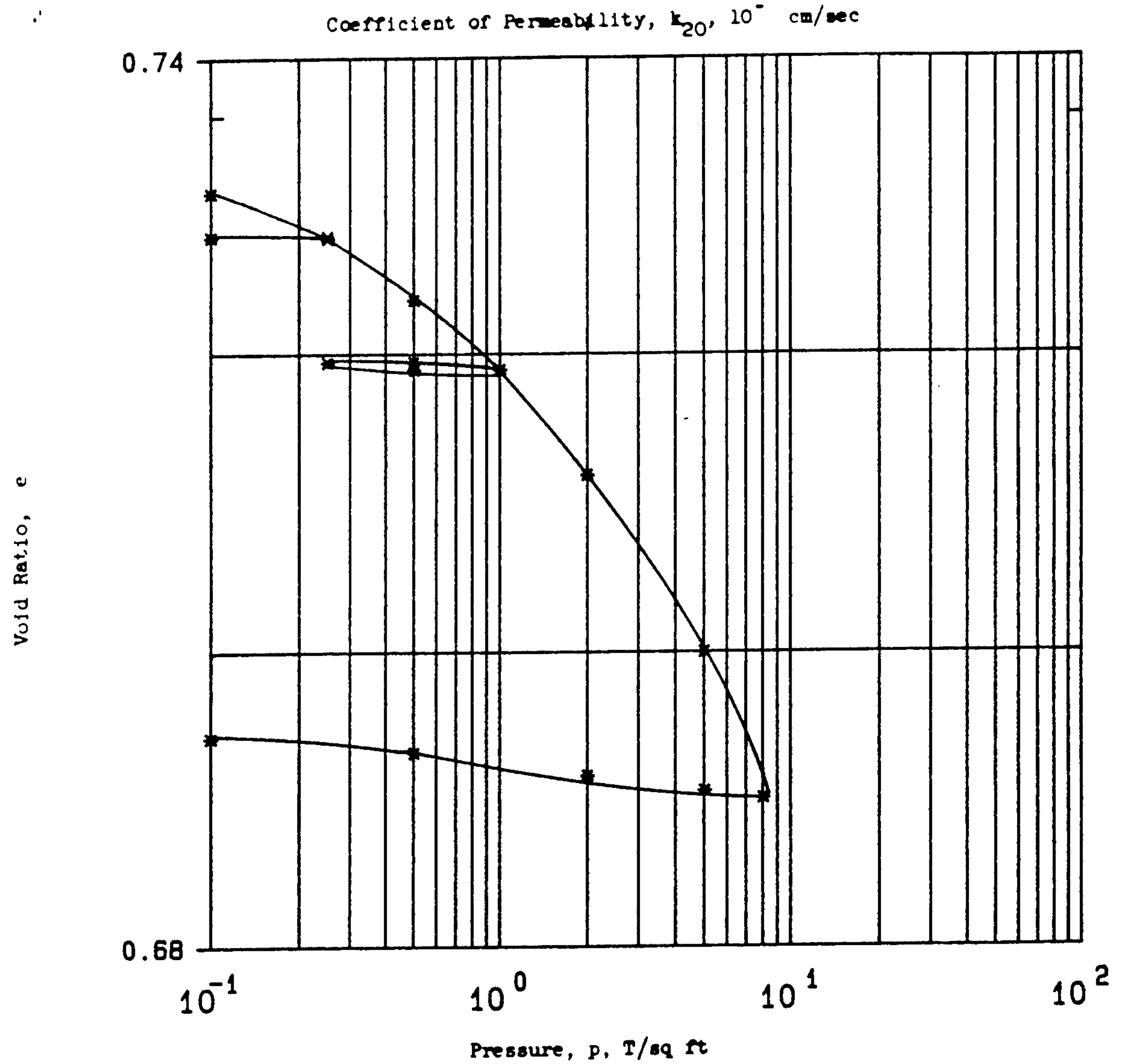


Type of Specimen UNDISTURBED		Before Test		After Test	
Diam 4.4 in.	Ht 1 in.	Water Content, w_o	0.0 %	w_f	0.0 %
Overburden Pressure, p_o T/sq ft		Void Ratio, e_o	0.74	e_f	0.69
Preconsol. Pressure, p_c T/sq ft		Saturation, S_o	0 %	S_f	0 %
Compression Index, C_c		Dry Density, γ_d	95.6 lb/ft^3		
Classification Sandy, SP		k_{20} at e_o = x 10^{-} cm/sec			
LL	G_s 2.66	Project	CHASKA; CENCS-91-45-ED-GH		
PL	D_{10}				
Remarks Brown. The sand was		Area	MRD LAB NO. 839		
placed inside the consolidometer		Boring No.	91-148A	Sample No.	SN-1
ring in a state dense as possible		Depth El	8'-12'	Date	04-29-91

CONSOLIDATION TEST REPORT

ENG FORM 2090 1 MAY 63 PREVIOUS EDITIONS ARE OBSOLETE.

Figure 30



Type of Specimen UNDISTURBED		Before Test		After Test	
Diam 4.4 in.	Ht 1 in.	Water Content, w_o	0.0 %	w_f	0.0 %
Overburden Pressure, Po T/sq ft		Void Ratio, e_o	0.74	e_f	0.69
Preconsol. Pressure, Pc T/sq ft		Saturation, S_o	0 %	S_f	0 %
Compression Index, C_c		Dry Density, γ_d	95.6 lb/ft^3		
Classification Sandy, SP		k_{20} at e_o = × 10^{-} cm/sec			
LL	G_s 2.66	Project	CHASKA; CENCS-91-45-ED-6H		
PL	D_{10}				

Area	MRD LAB NO. 839		
Boring No.	91-148A	Sample No.	SN-1
Depth El	8'-12'	Date	04-29-91

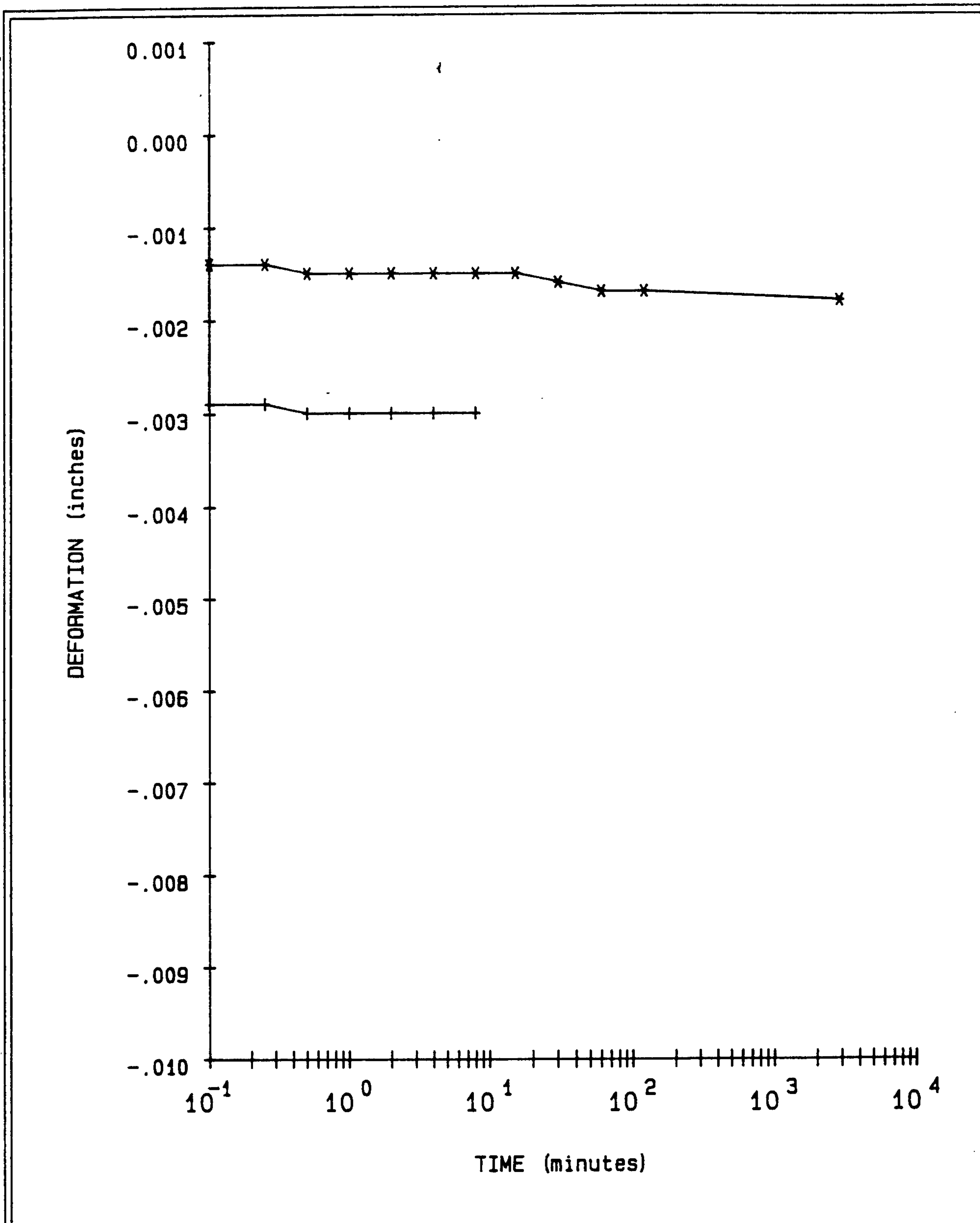
Remarks Brown. The sand was placed inside the consolidometer ring in a state dense as possible.

CONSOLIDATION TEST REPORT

ENG FORM 2090 1 MAY 63 PREVIOUS EDITIONS ARE OBSOLETE.

Figure 31

FIGURE D-214



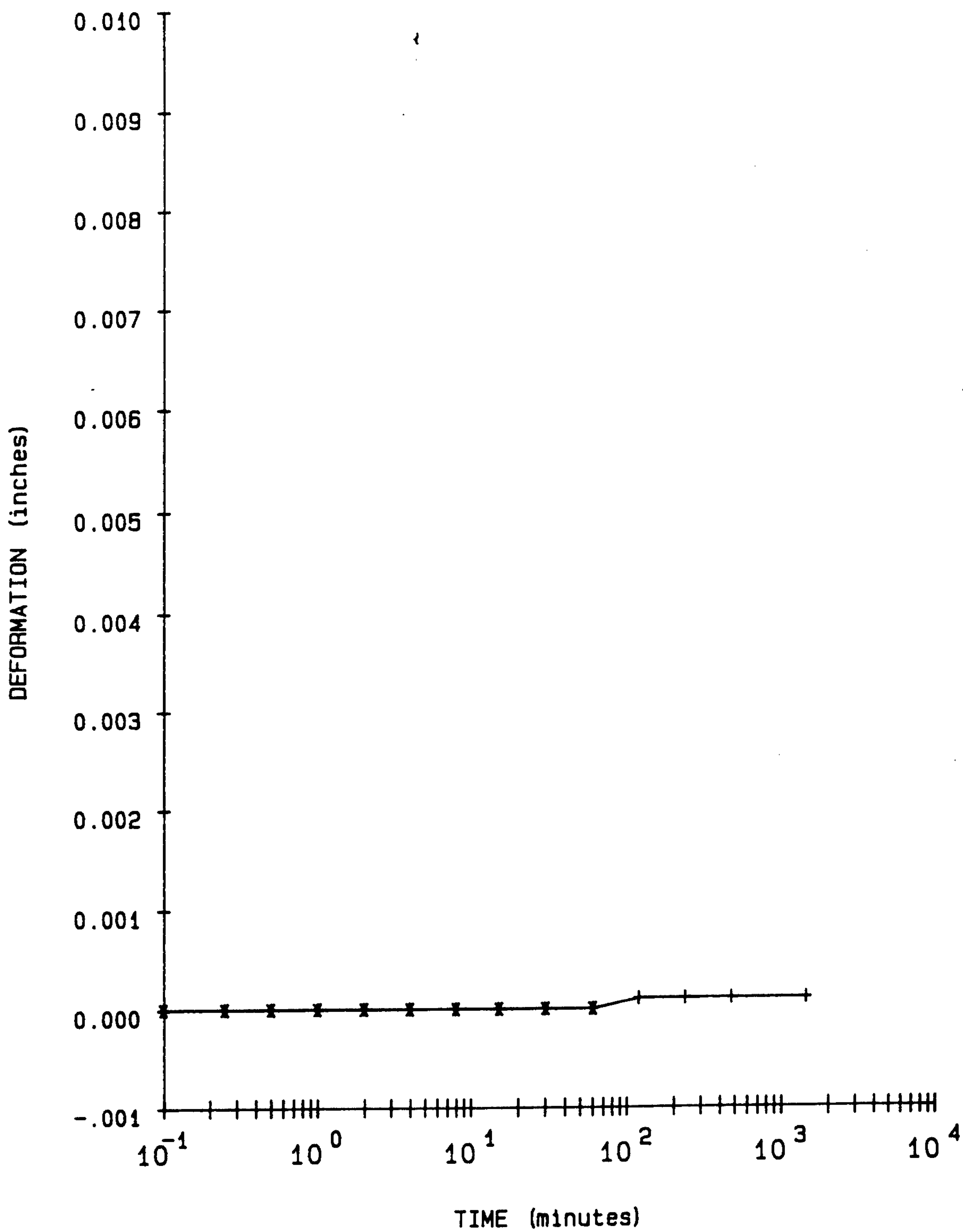
LEGEND

+ = .1 TSF Dry

* = .25 TSF Dry

PROJECT	CHASKA: CENCS-91-45-ED-GH
BORING NO.	91-148A
SAMPLE NO.	SN-1
DEPTH/ELEV	8'-12'
MRD LAB NO.	839

FIGURE 32

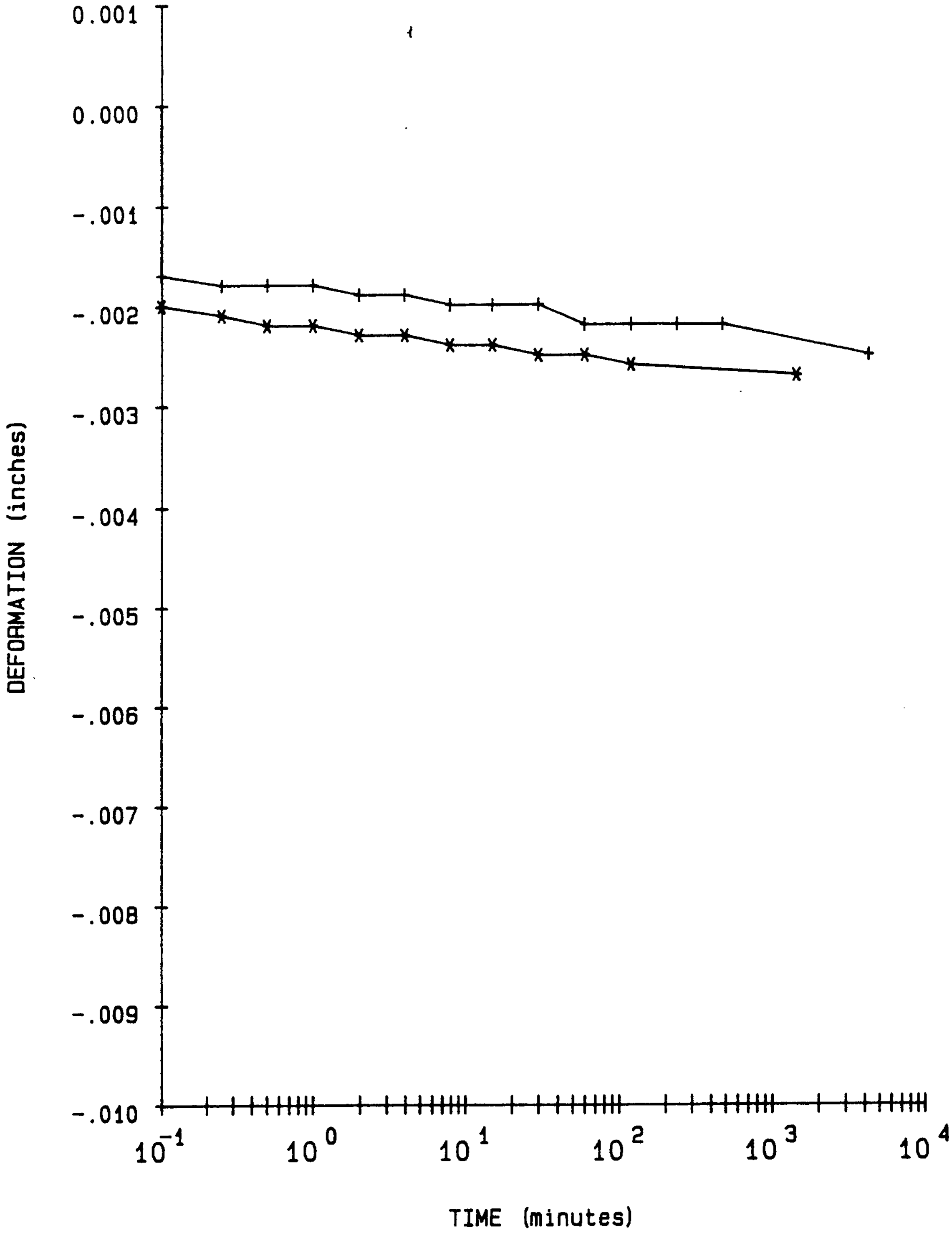


LEGEND	
+ = .1 TSF Dry Rebound	
* = .25 TSF Dry	

PROJECT	CHASKA: CENCS-91-45-ED-GH
BORING NO.	91-148A
SAMPLE NO.	SN-1
DEPTH/ELEV	8'-12'
MRD LAB NO.	839

FIGURE 33

FIGURE D-216

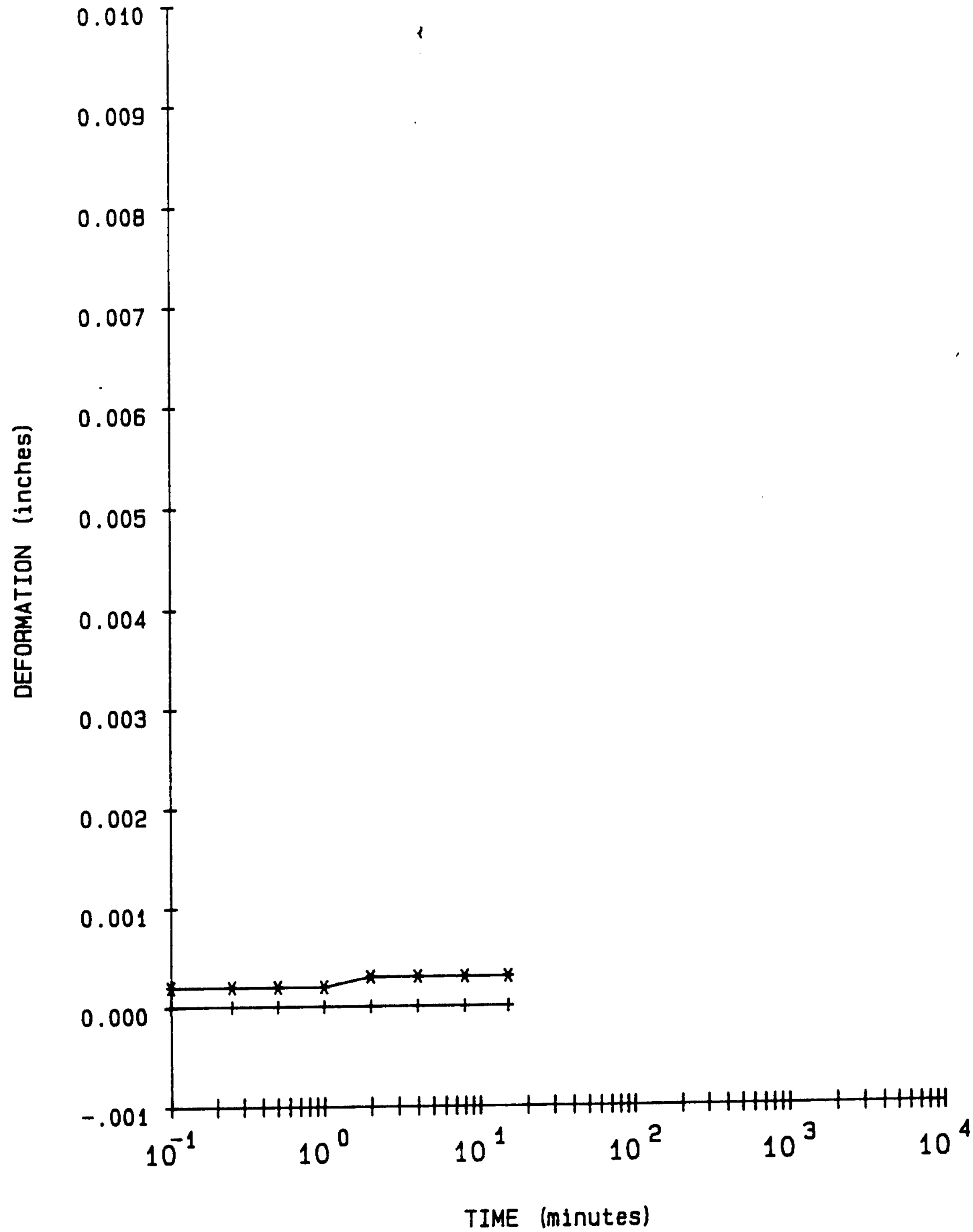


LEGEND
+ = .5 TSF Dry
* = 1 TSF Dry

PROJECT	CHASKA: CENCS-91-45-ED-GH
BORING NO.	91-148A
SAMPLE NO.	SN-1
DEPTH/ELEV	8'-12'
MRD LAB NO.	839

FIGURE 34

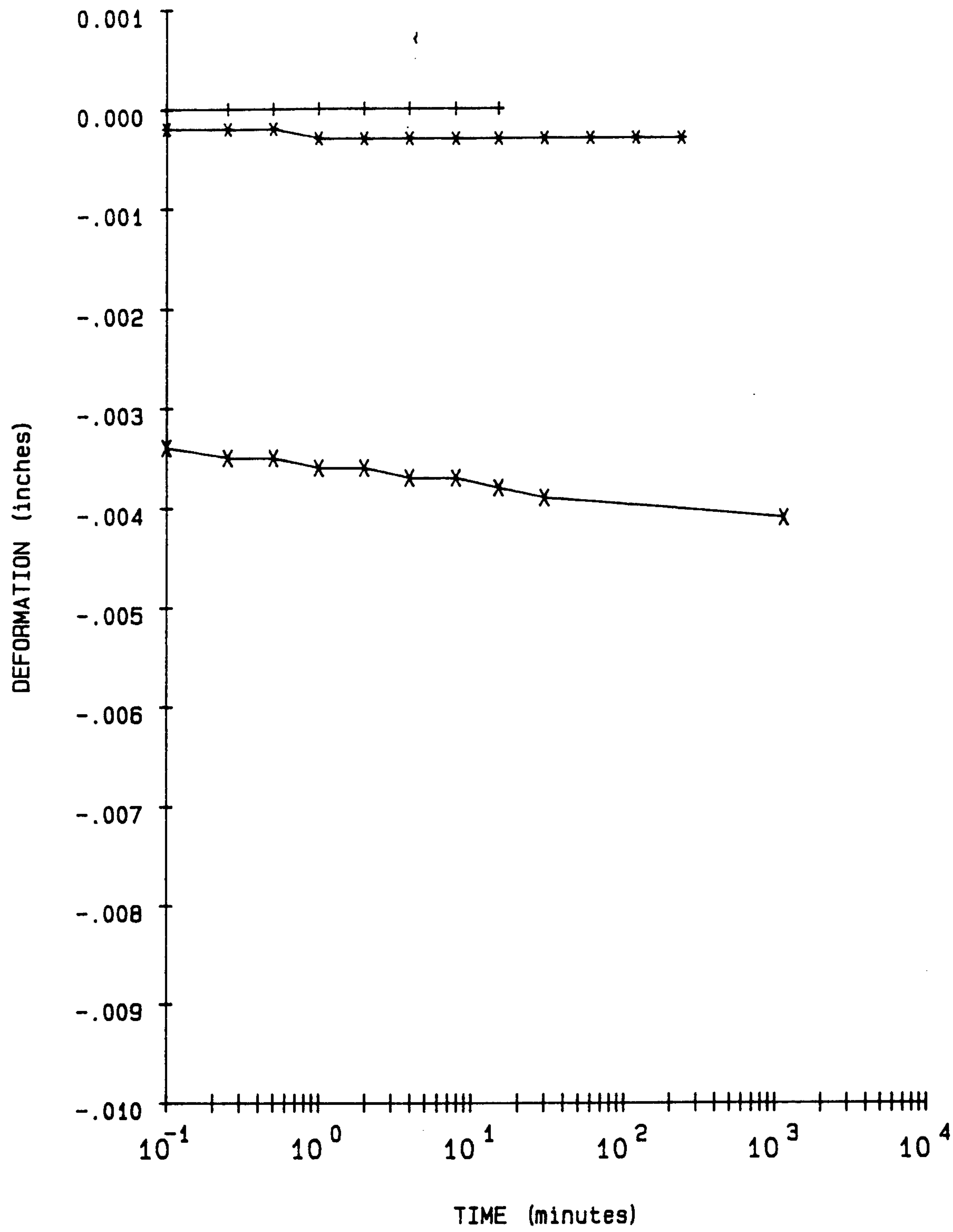
FIGURE D-217



LEGEND
+ = .5 TSF Dry Rebound
* = .25 TSF Dry Rebound

PROJECT	CHASKA: CENCS-91-45-ED-GH
BORING NO.	91-148A
SAMPLE NO.	SN-1
DEPTH/ELEV	8'-12'
MRD LAB NO.	839

FIGURE 35

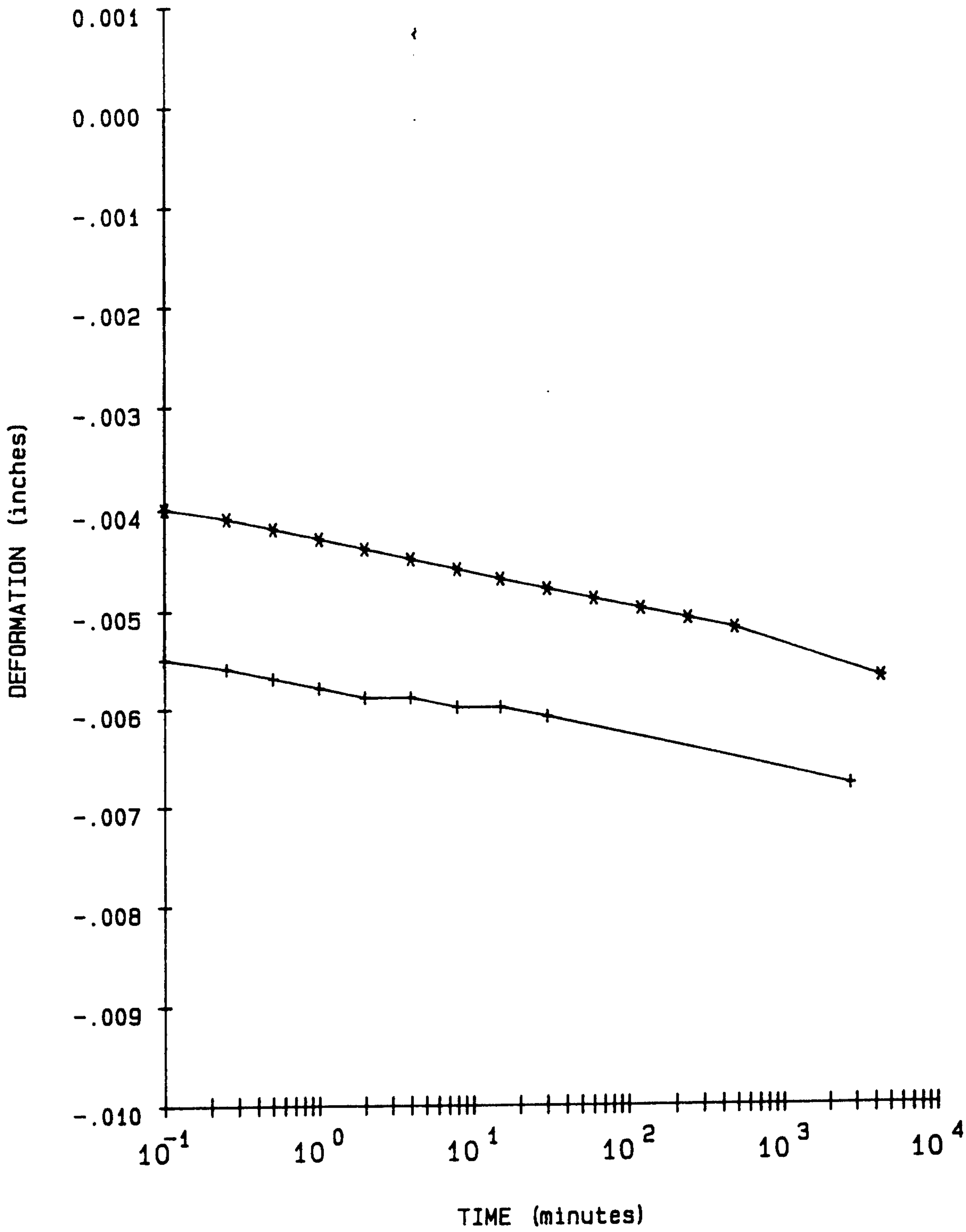


LEGEND	
+ = .5 TSF Dry	
* = 1 TSF Dry	
X = 2 TSF Dry	

PROJECT	CHASKA: CENCS-91-45-ED-GH
BORING NO.	91-148A
SAMPLE NO.	SN-1
DEPTH/ELEV	8'-12'
MRD LAB NO.	839

FIGURE 36

FIGURE D-219



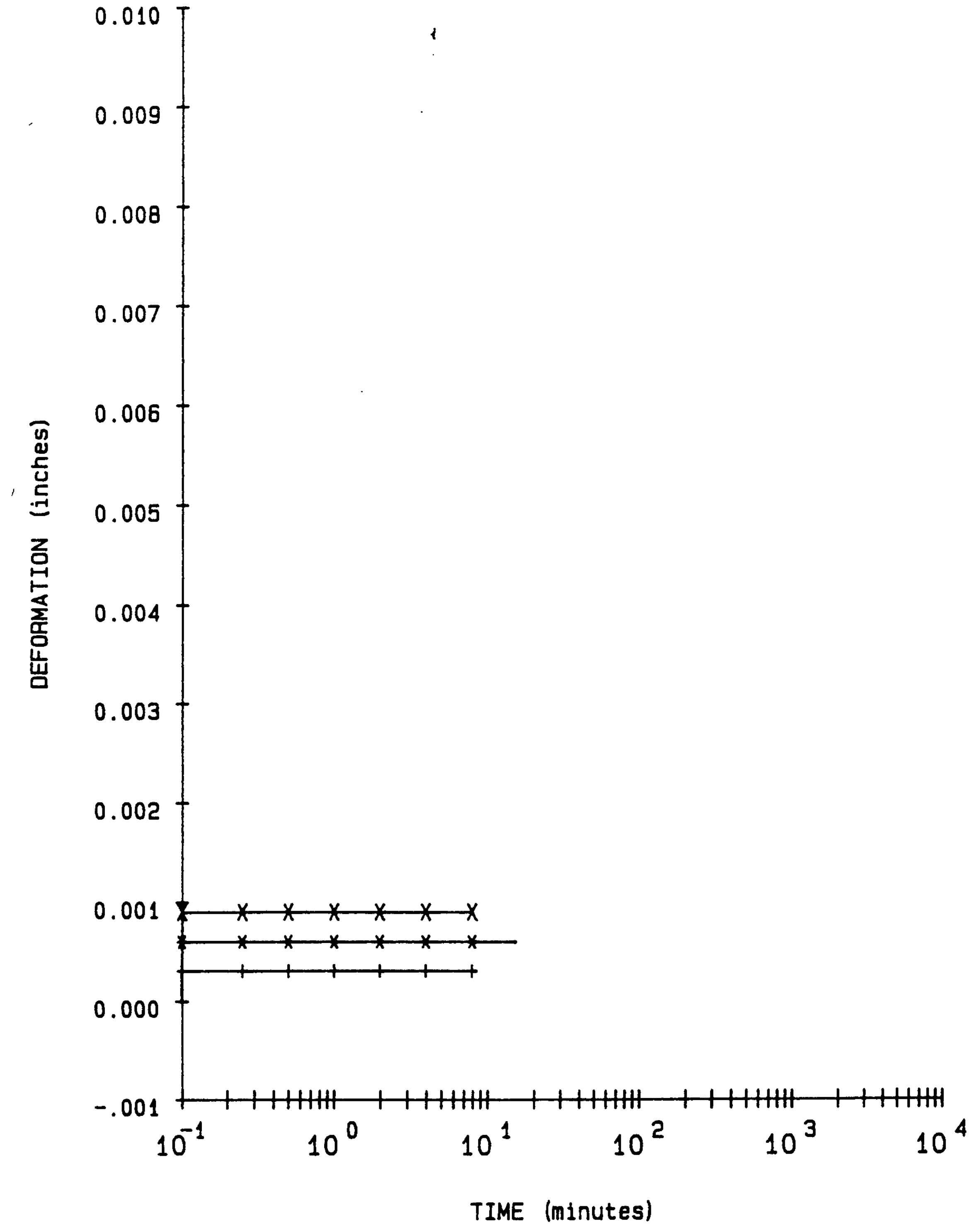
LEGEND

+ = 5 TSF Dry

* = 8 TSF Dry

PROJECT	CHASKA: CENCS-91-45-ED-GH
BORING NO.	91-148A
SAMPLE NO.	SN-1
DEPTH/ELEV	8'-12'
MRD LAB NO.	839

FIGURE 37



LEGEND			
+ =	5	TSF	Dry Rebound
* =	2	TSF	Dry Rebound
X =	.5	TSF	Dry Rebound
- =	.1	TSF	Dry Rebound

PROJECT	CHASKA: CENCS-91-45-ED-GH
BORING NO.	91-148A
SAMPLE NO.	SN-1
DEPTH/ELEV	8'-12'
MRD LAB NO.	839

FIGURE 38

FIGURE D-221

Consolidation Test Data

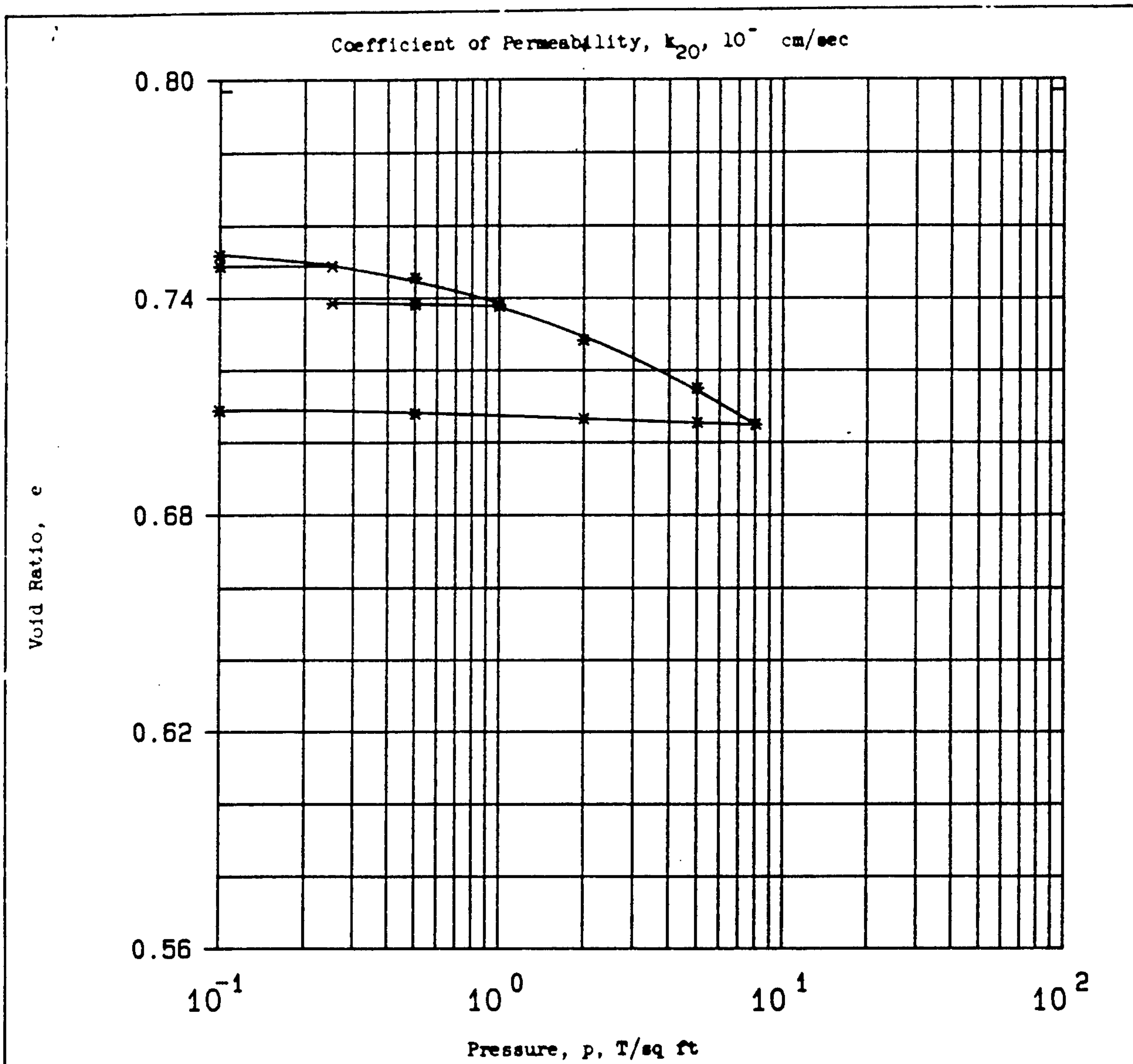
Project CHASKA; CENCS-91-45-ED-GH

Boring No. 91-148A
Sample No. SN-1
Depth/Elev 8'-12'
MRD Lab No. 839

Gs = 2.66
eo = 0.736
0.42eo = 0.309

Water Content (%)	Dry Weight (gms)	Dry Density (PCF)	Void Ratio	Pressure (TSF)	Saturation (%)
0.0	388.4	95.6	0.736		0.0
0.0	388.4	95.9	0.731	0.10	0.0
0.0	388.4	96.1	0.728	0.25	0.0
0.0	388.4	96.1	0.728	0.10	0.0
0.0	388.4	96.1	0.728	0.25	0.0
0.0	388.4	96.3	0.724	0.50	0.0
0.0	388.4	96.6	0.719	1.00	0.0
0.0	388.4	96.6	0.719	0.50	0.0
0.0	388.4	96.5	0.719	0.25	0.0
0.0	388.4	96.5	0.719	0.50	0.0
0.0	388.4	96.6	0.719	1.00	0.0
0.0	388.4	97.0	0.712	2.00	0.0
0.0	388.4	97.6	0.700	5.00	0.0
0.0	388.4	98.2	0.690	8.00	0.0
0.0	388.4	98.2	0.691	5.00	0.0
0.0	388.4	98.1	0.692	2.00	0.0
0.0	388.4	98.0	0.693	0.50	0.0
0.0	388.4	98.0	0.694	0.10	0.0

Axial Strain (%)	Void Ratio
1	0.719
2	0.701
3	0.684
4	0.667
5	0.649

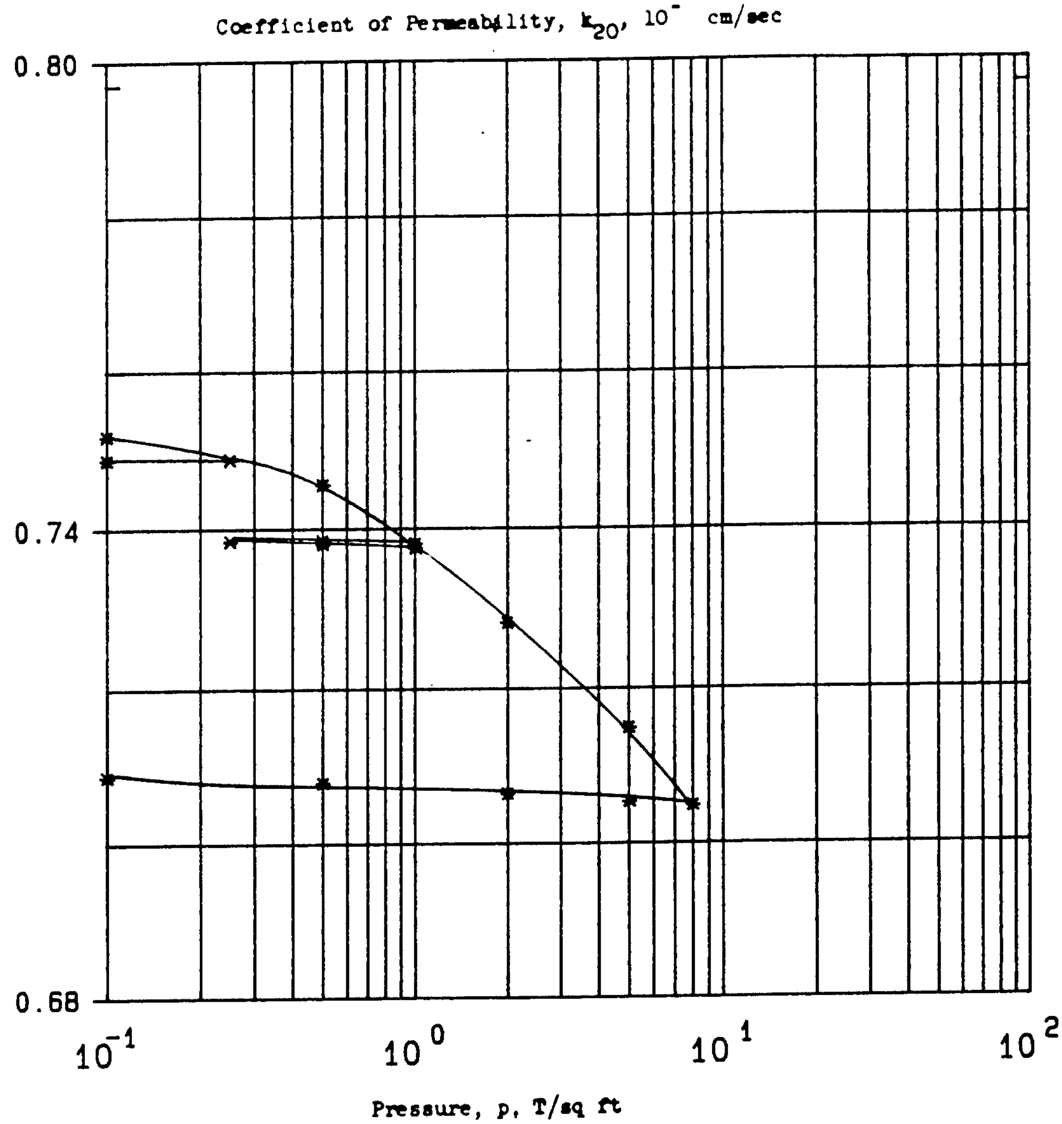


Type of Specimen REMOLDED		Before Test		After Test	
Diam 4.4 in.	Ht 1 in.	Water Content, w_o	0.1 %	w_f	0.1 %
Overburden Pressure, Po T/sq ft		Void Ratio, e_o	0.80	e_f	0.71
Preconsol. Pressure, Pc T/sq ft		Saturation, S_o	0 %	S_f	1 %
Compression Index, C_c		Dry Density, γ_d	92.4 lb/ft^3		
Classification Sandy, SP		k_{20} at e_o = × 10^{-} cm/sec			
LL	G_s 2.66	Project	CHASKA; CENCS-IA-91-45-ED-GH		
PL	D_{10}				
Remarks Brown. The sand was placed in the consolidometer ring in a state as loose as possible.		Area	MRD LAB NO. 839		
		Boring No.	91-148A	Sample No.	SN-1
		Depth El	8'-12'	Date	04-11-91

CONSOLIDATION TEST REPORT

ENG FORM 1 MAY 63 2090 PREVIOUS EDITIONS ARE OBSOLETE.

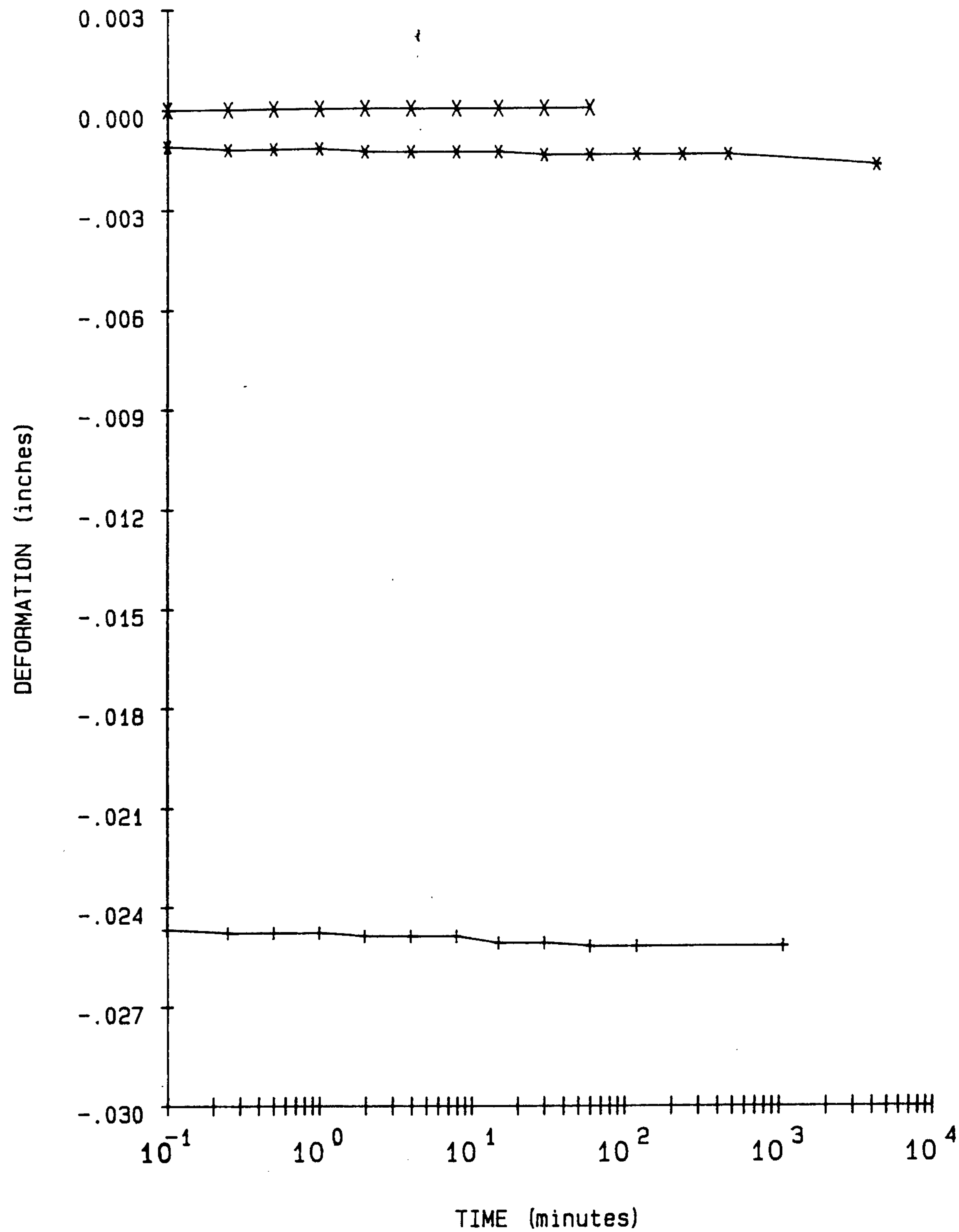
Figure 39



Type of Specimen REMOLDED		Before Test		After Test	
Diam 4.4 in.	Ht 1 in.	Water Content, w_o	0.1 %	w_f	0.1 %
Overburden Pressure, Po T/sq ft		Void Ratio, e_o	0.80	e_f	0.71
Preconsol. Pressure, Pc T/sq ft		Saturation, S_o	0 %	S_f	1 %
Compression Index, C_c		Dry Density, γ_d	92.4 lb/ft^3		
Classification Sand		k_{20} at e_o = × 10⁻ cm/sec			
LL	G_s 2.66	Project	CHASKA; CENCS-IA-91-45-ED-GH		
PL	D_{10}				
Remarks Brown. The sand was		Area ---	MRD LAB NO. 839		
placed inside the consoliometer		Boring No.	91-148A	Sample No.	SN-1
ring in a state as loose as		Depth El	8'-12'	Date	04-11-91
possible.		CONSOLIDATION TEST REPORT			

ENG FORM 2090 1 MAY 63 PREVIOUS EDITIONS ARE OBSOLETE.

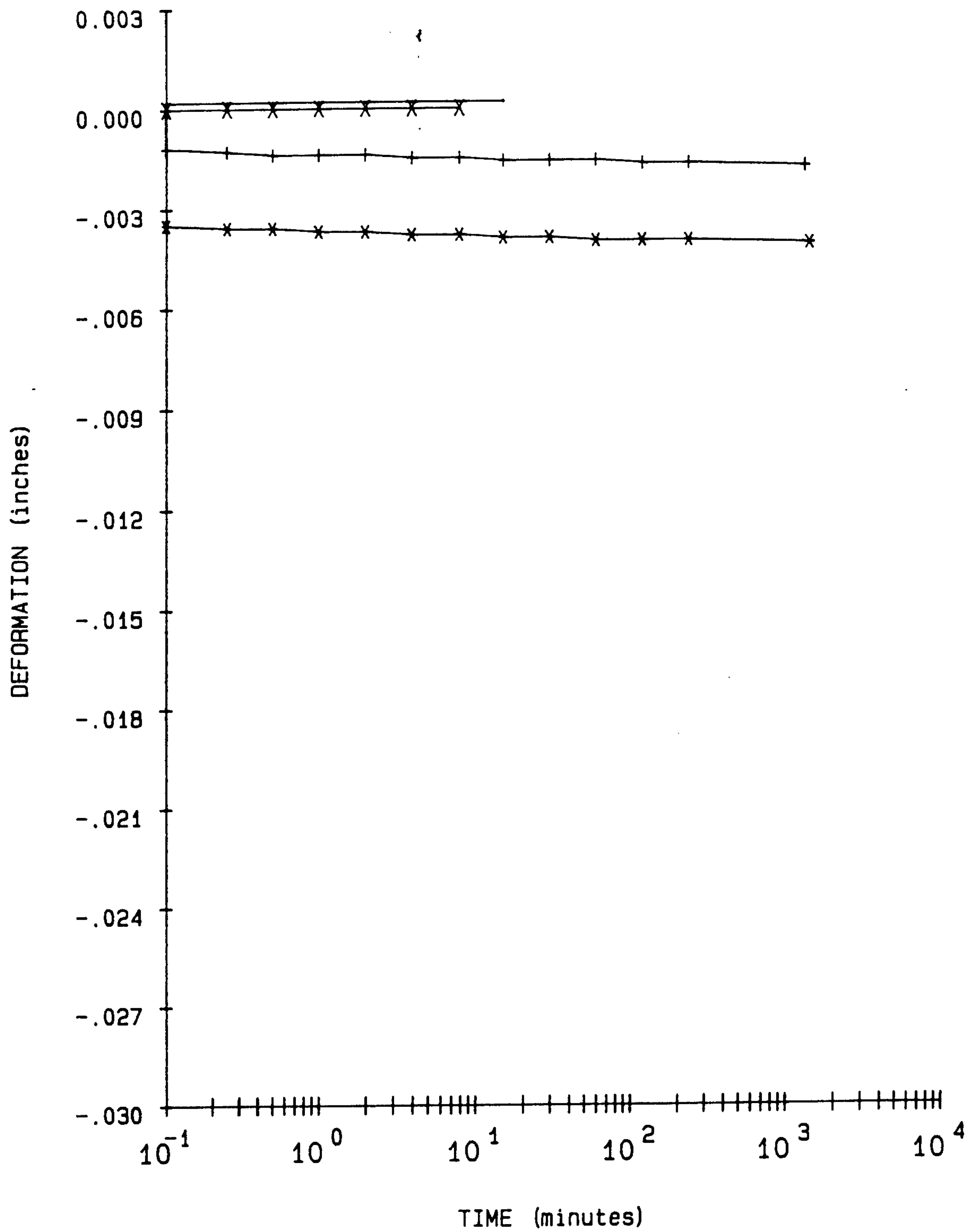
Figure 40



LEGEND		
+ =	.1 TSF	Dry
* =	.25 TSF	Dry
X =	.1 TSF	Dry Rebound
- =	.25 TSF	Dry

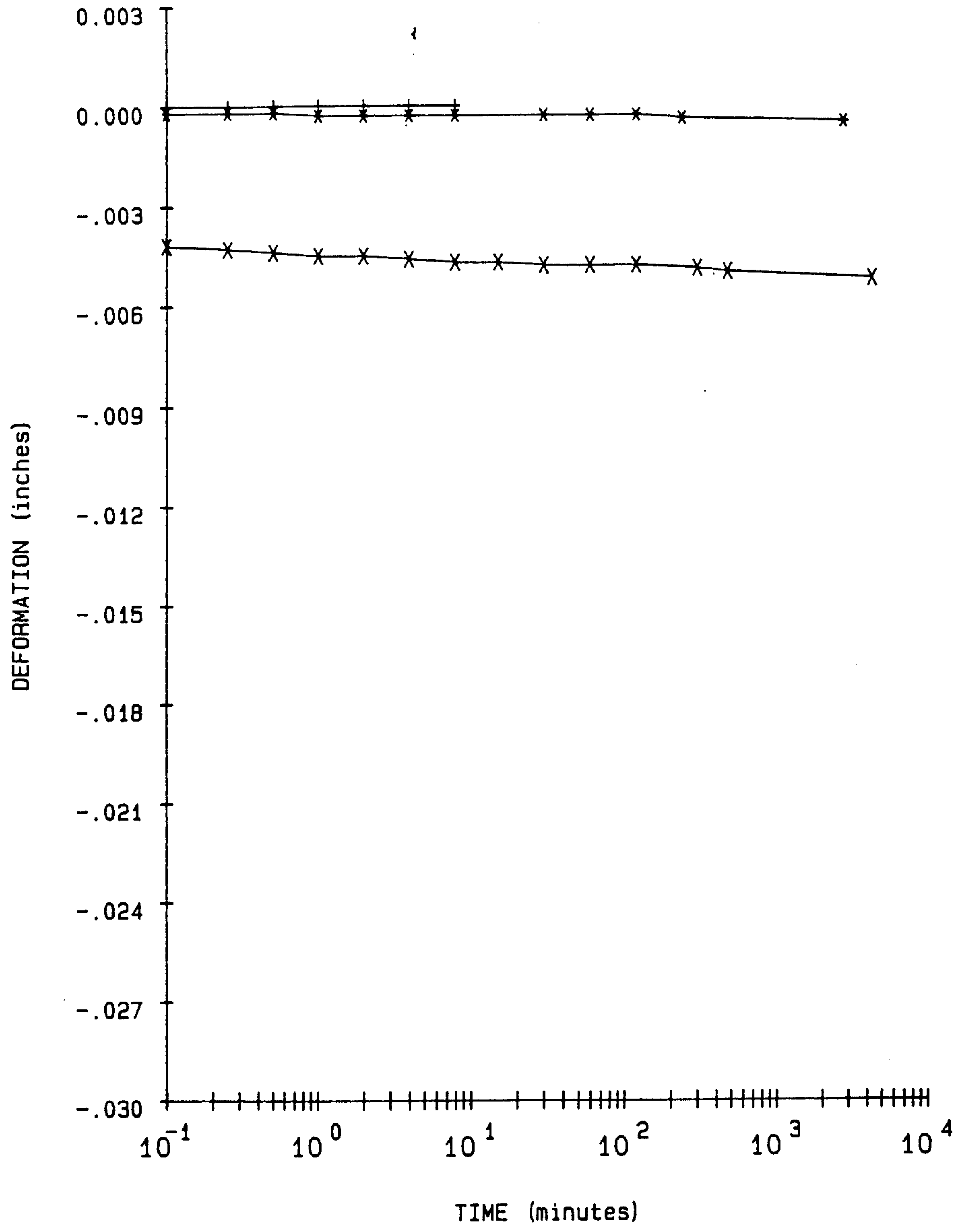
PROJECT	CHASKA; CENCS-IA-91-45-ED-GH
BORING NO.	91-148A
SAMPLE NO.	SN-1
DEPTH/ELEV	8'-12'
MRD LAB NO.	839

FIGURE 41



LEGEND	PROJECT	CHASKA: CENCS-IA-91-45-ED-GH
+ = .5 TSF Dry	BORING NO.	91-148A
✱ = 1 TSF Dry	SAMPLE NO.	SN-1
X = .5 TSF Dry Rebound	DEPTH/ELEV	8'-12'
– = .25 TSF Dry Rebound	MRD LAB NO.	839

FIGURE 42



LEGEND

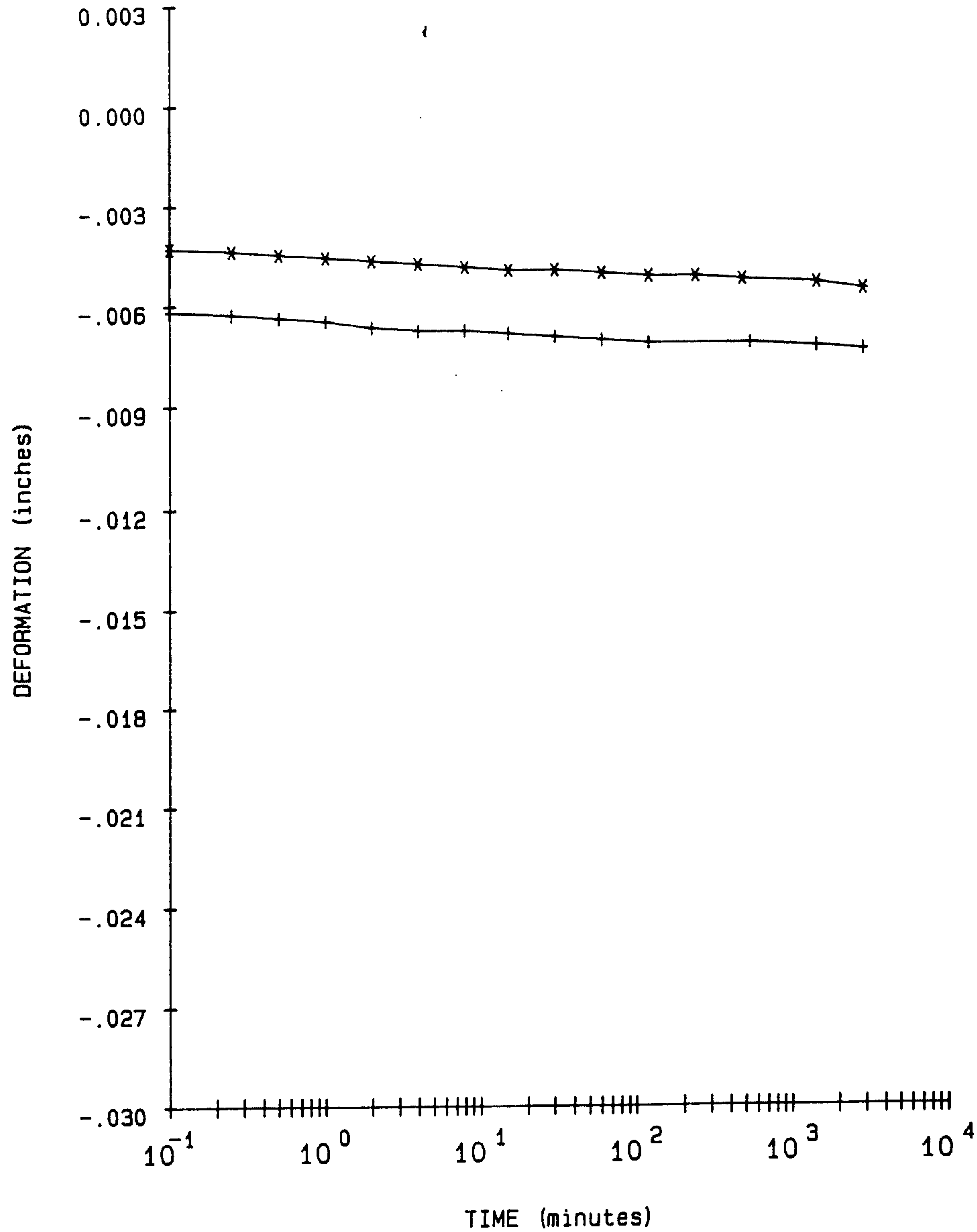
+ = .5 TSF Dry

* = 1 TSF Dry

X = 2 TSF Dry

PROJECT	CHASKA; CENCS-IA-91-45-ED-GH
BORING NO.	91-148A
SAMPLE NO.	SN-1
DEPTH/ELEV	8'-12'
MRD LAB NO.	839

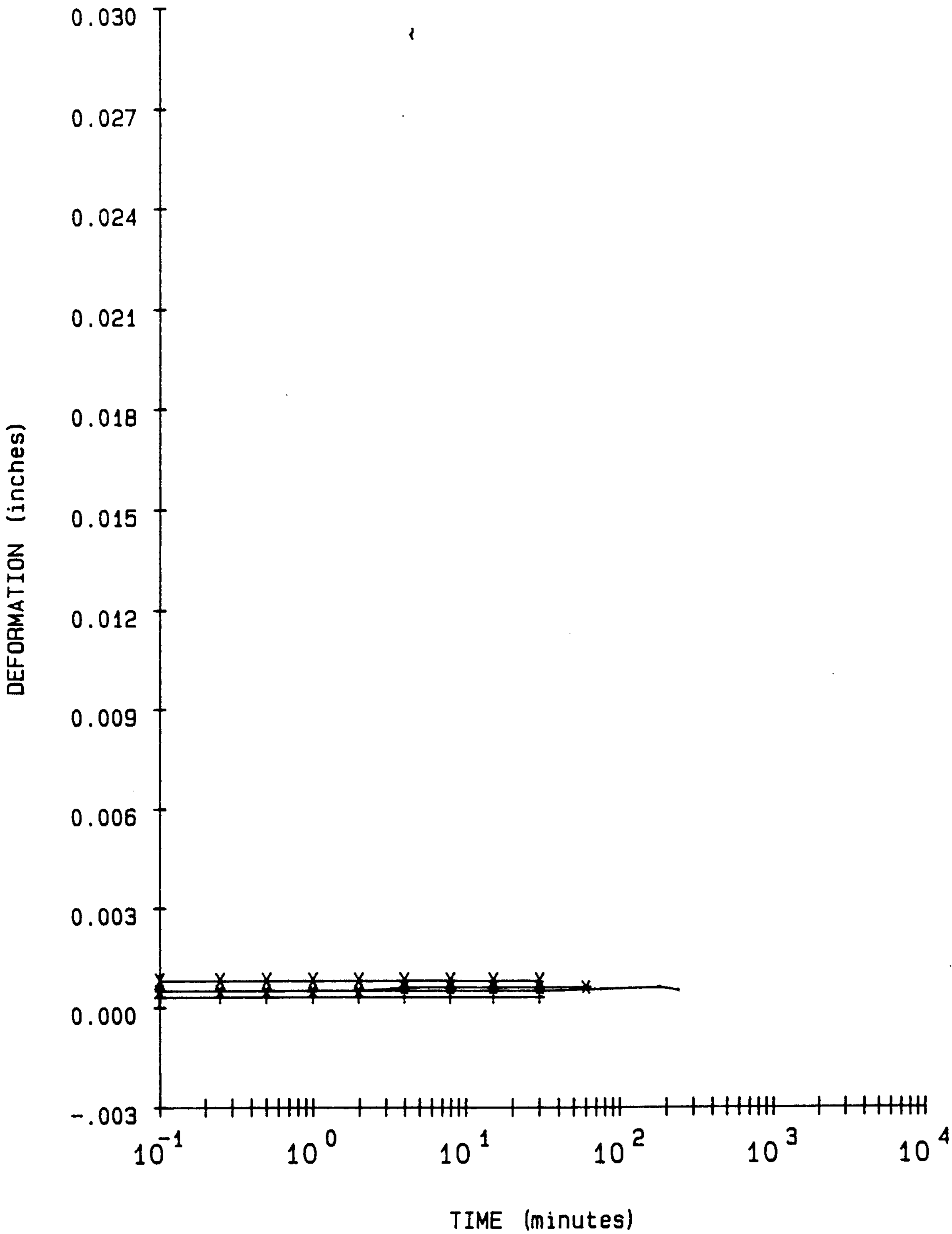
FIGURE 43



LEGEND
+ = 5 TSF Dry
* = 8 TSF Dry

PROJECT	CHASKA: CENCS-IA-91-45-ED-GH
BORING NO.	91-148A
SAMPLE NO.	SN-1
DEPTH/ELEV	8'-12'
MRD LAB NO.	839

FIGURE 44



LEGEND			
+ =	5	TSF	Dry Rebound
* =	2	TSF	Dry Rebound
X =	.5	TSF	Dry Rebound
- =	.1	TSF	Dry Rebound

PROJECT	CHASKA; CENCS-IA-91-45-ED-GH
BORING NO.	91-148A
SAMPLE NO.	SN-1
DEPTH/ELEV	8'-12'
MRD LAB NO.	839

FIGURE 45

FIGURE D-229

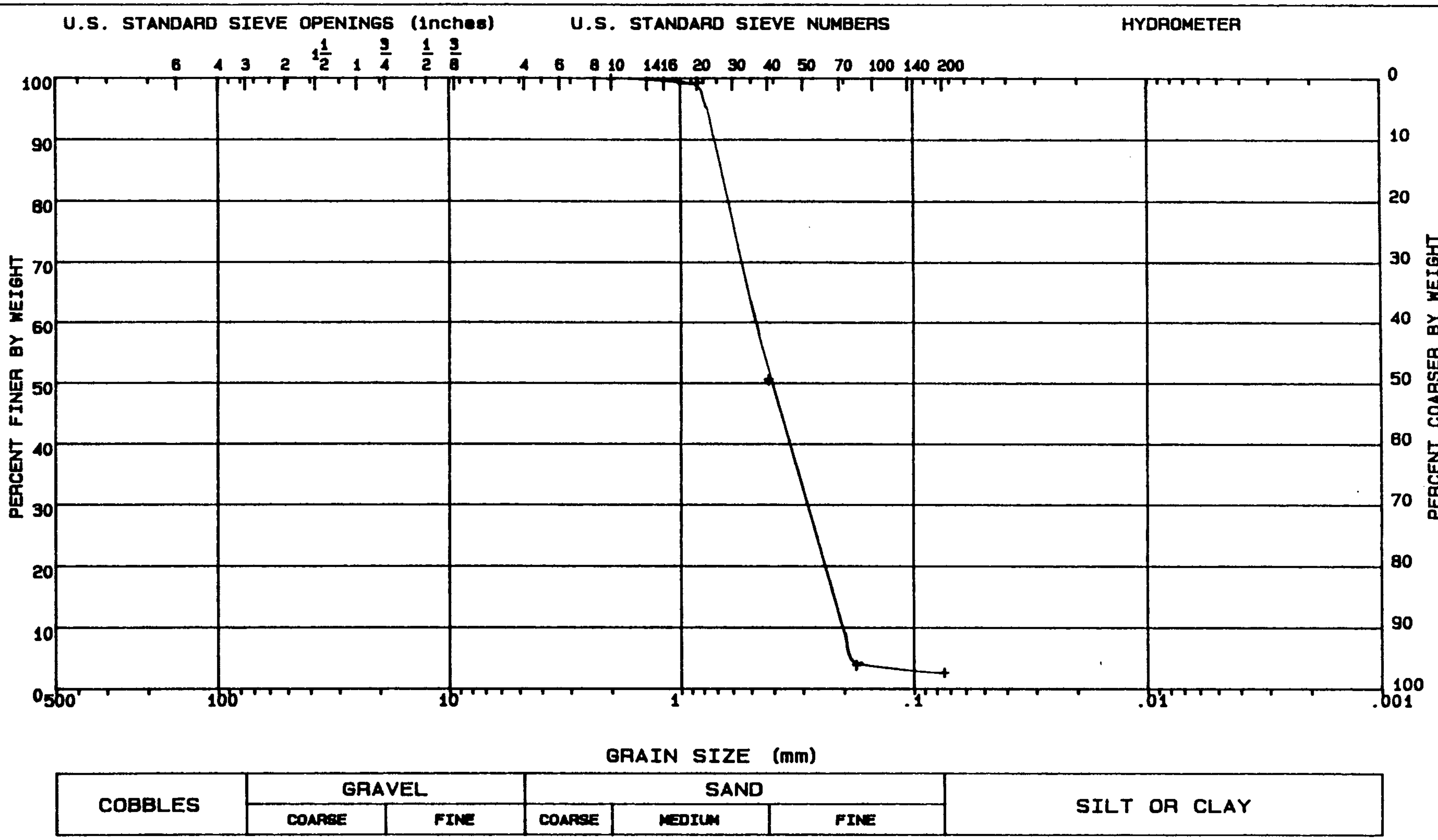
Consolidation Test Data

Project	CHASKA; CENCS-IA-91-45-ED-GH
Boring No.	91-148A
Sample No.	SN-1
Depth/Elev	8'-12'
MRD Lab No.	839

Gs = 2.66
eo = 0.797
0.42eo = 0.335

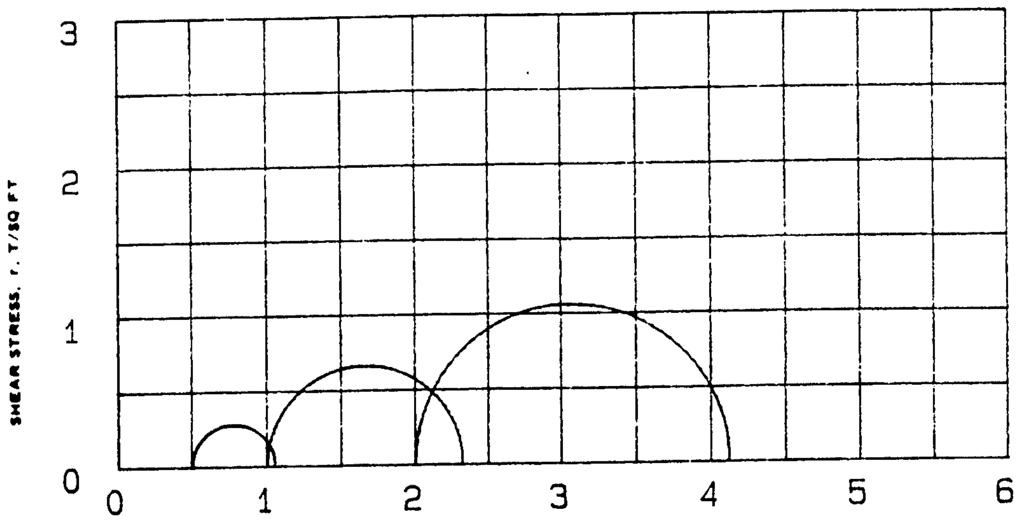
Water Content (%)	Dry Weight (gms)	Dry Density (PCF)	Void Ratio	Pressure (TSF)	Saturation (%)
0.1	375.2	92.4	0.797		0.5
0.1	375.2	94.8	0.752	0.10	0.5
0.1	375.2	94.9	0.749	0.25	0.5
0.1	375.2	94.9	0.749	0.10	0.5
0.1	375.2	94.9	0.749	0.25	0.5
0.1	375.2	95.1	0.745	0.50	0.5
0.1	375.2	95.5	0.738	1.00	0.5
0.1	375.2	95.5	0.738	0.50	0.5
0.1	375.2	95.5	0.738	0.25	0.5
0.1	375.2	95.5	0.738	0.50	0.5
0.1	375.2	95.5	0.738	1.00	0.5
0.1	375.2	96.0	0.728	2.00	0.5
0.1	375.2	96.8	0.715	5.00	0.5
0.1	375.2	97.4	0.705	8.00	0.5
0.1	375.2	97.3	0.705	5.00	0.5
0.1	375.2	97.3	0.706	2.00	0.5
0.1	375.2	97.2	0.708	0.50	0.5
0.1	375.2	97.1	0.709	0.10	0.5

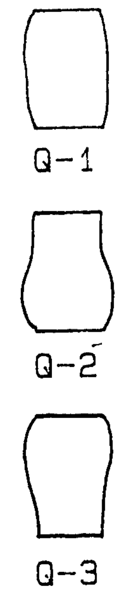
Axial Strain (%)	Void Ratio
1	0.779
2	0.761
3	0.743
4	0.725
5	0.707
6	0.689
7	0.671
8	0.653

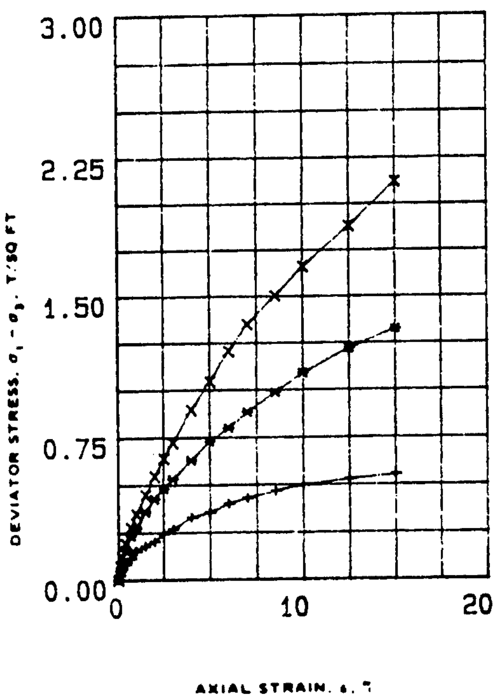


LL =	PL =	PI =	Gs = 2.66	NAT w = %	PROJECT	CHASKA; CENCS-IA-91-45-ED-GH
CLASSIFICATION Sandy, SP					DATE	04-03-91
					BORING NO.	91-148A
					SAMPLE NO.	S-1
GRADATION CURVE					DEPTH/ELEV	8.2'-12'
					MRD LAB NO.	839

FIGURE 46







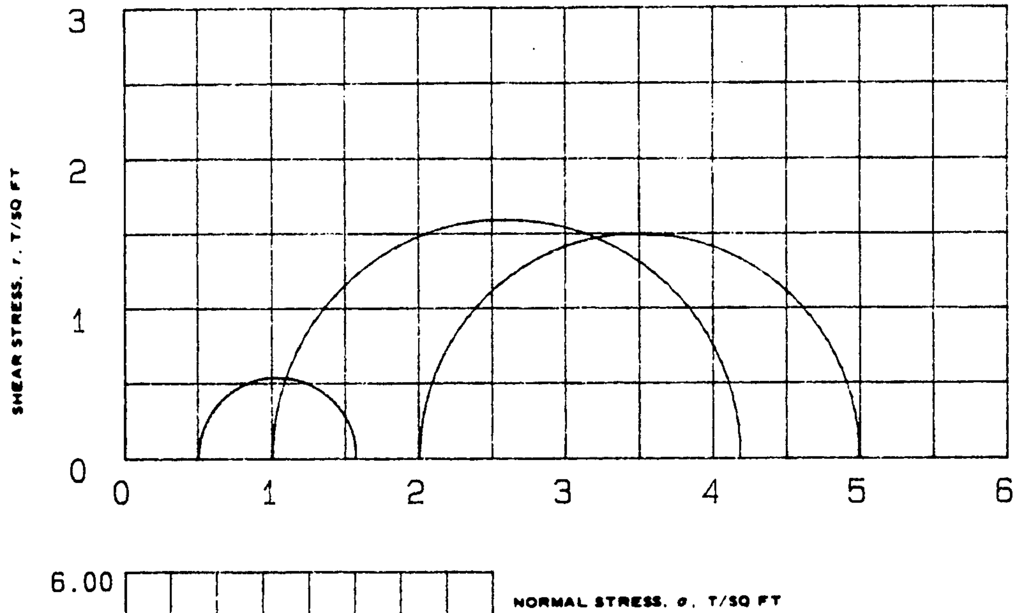
SPECIMEN NO.			1 (+)	2 (*)	3 (X)
INITIAL	WATER CONTENT, %	w_o	23.0	28.3	24.7
	DRY DENSITY LB/CU FT	γ_{d_o}	104.3	91.8	101.6
	SATURATION, %	S_o	100.0	92.0	100.0
	VOID RATIO	e_o	0.61	0.83	0.65
BEFORE SHEAR	WATER CONTENT, %	w_c	22.7	27.4	23.6
	DRY DENSITY LB/CU FT	γ_{d_c}	104.3	91.8	101.9
	SATURATION, %	S_c	100.0	89.0	98.0
	VOID RATIO	e_c	0.61	0.83	0.65
	FINAL BACK PRESSURE, T/SQ FT	u_o	0.0	0.0	0.0
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	0.5	1.0	2.0
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	0.55	1.32	2.12
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	33.3	33.3	32.5
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	0.55	1.32	2.12
INITIAL DIAMETER, IN.		D_o	1.40	1.40	1.40
INITIAL HEIGHT, IN.		H_o	3.00	3.00	3.00

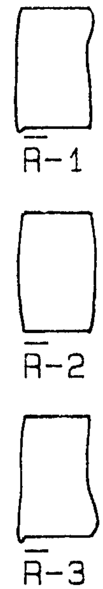
CONTROLLED- STRAIN TEST

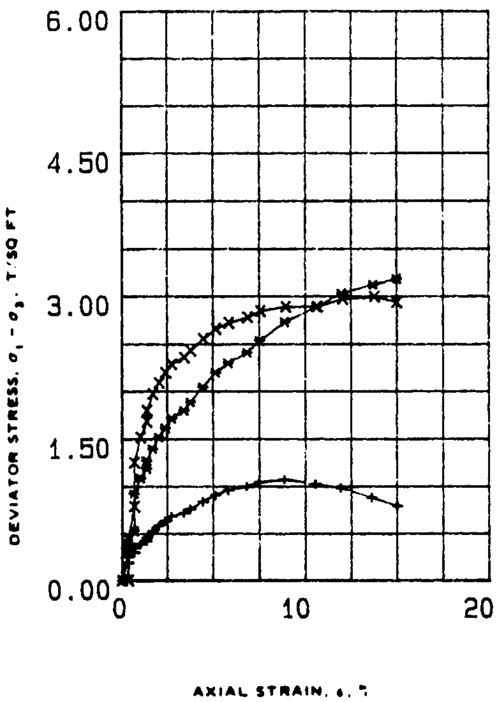
DESCRIPTION OF SPECIMENS Sandy Silt, ML

LL 23	PL 19	PI 4	G_s 2.69	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST Q
REMARKS: Gray. Torvane=.60 TSF.				PROJECT CHASKA; CENCS-IA-92-97-ED-GH	
Specimens too soft to measure				BORING NO 92-169 MU	SAMPLE NO. W-1
dimensions accurately. Free surface				DEPTH ELEV 12.5'-14.5'	
water on sample.				LABORATORY 1535	DATE 7-6-92
				TRIAXIAL COMPRESSION TEST REPORT	

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906) FIGURE 1







			1 (+)	2 (*)	3 (X)
SPECIMEN NO.			1 (+)	2 (*)	3 (X)
INITIAL	WATER CONTENT, %	w_o	23.4	26.8	30.5
	DRY DENSITY LB/CU FT	γ_{d_o}	103.2	98.9	94.9
	SATURATION, %	S_o	100	100	100
	VOID RATIO	e_o	.63	.7	.77
BEFORE SHEAR	WATER CONTENT, %	w_c	22.2	23.9	26.6
	DRY DENSITY LB/CU FT	γ_{d_c}	106.9	102.2	99.4
	SATURATION, %	S_c	100	100	100
	VOID RATIO	e_c	.57	.64	.69
	FINAL BACK PRESSURE, T/SQ FT	u_o	3.383	3.383	3.383
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.5	1	2
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	1.072	3.183	2.992
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	960	1411	1320
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	0.786	3.183	2.934
INITIAL DIAMETER, IN.		D_o	1.38	1.38	1.39
INITIAL HEIGHT, IN.		H_o	2.97	2.95	2.95
B-Value			1.0	1.0	1.0

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Sandy Silt, ML

LL	PL	PI	G_s
23	19	4	2.69

TYPE OF SPECIMEN UNDISTURBED — TYPE OF TEST RBAR

REMARKS: Gray, free surface water on sample, non-calcareous. Specimen soft, deforms easily. Torvane .06 TSF.

PROJECT CHASKA; CENCS-IA-92-97-ED-GH

BORING NO 92-169 MU — SAMPLE NO. W-1

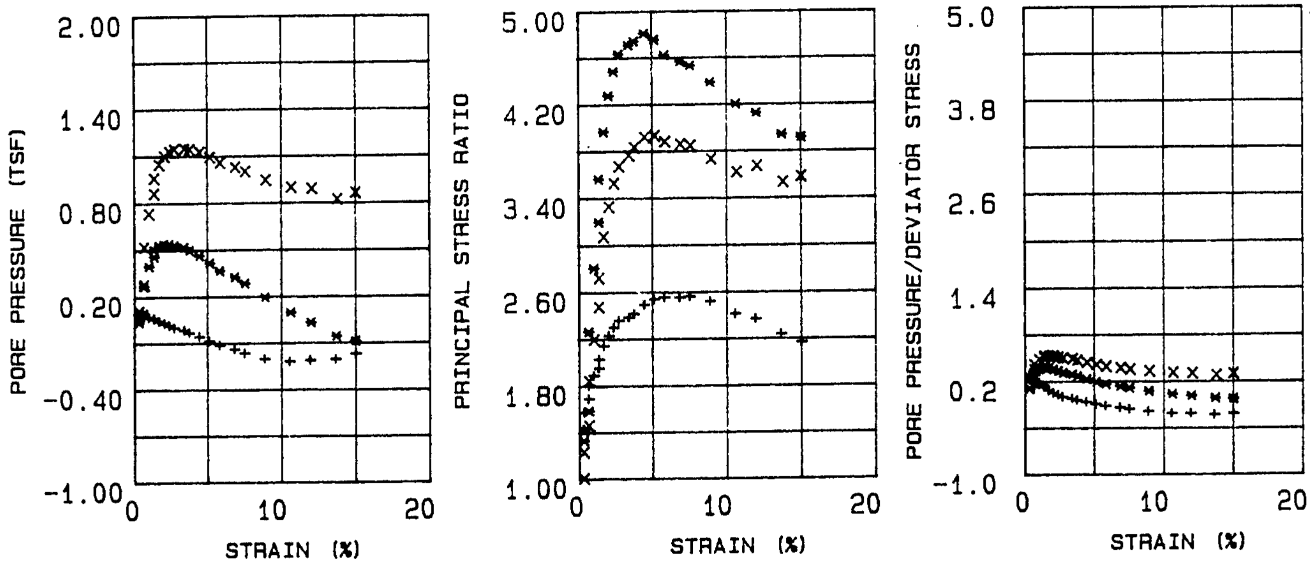
DEPTH ELEV 12.5'-14.5'

LABORATORY 1535 — DATE 08-14-92

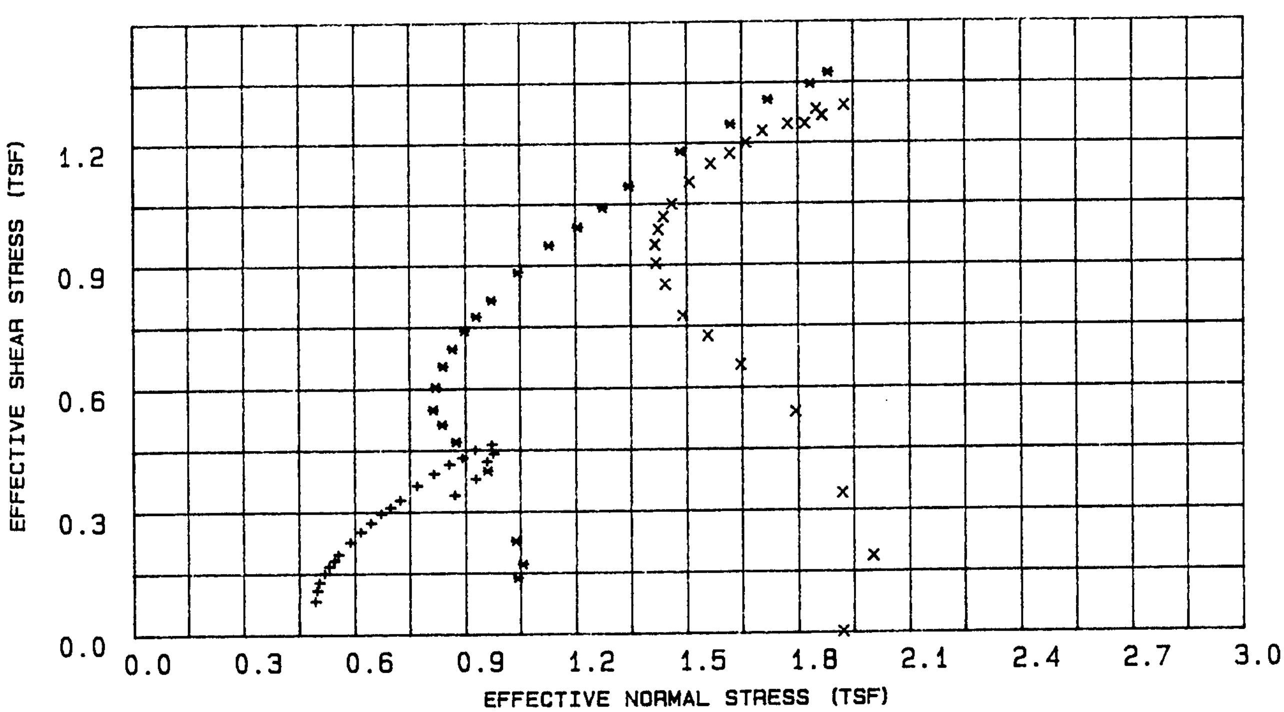
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 — PREVIOUS EDITION IS OBSOLETE — TRANSLUCENT — *(EM 1110-2-1906)*

FIGURE 1



EFFECTIVE STRESS VECTOR CURVES ON 60 DEGREE PLANE



LEGEND

+ = .5 TSF

* = 1 TSF

X = 2 TSF

PROJECT	CHASKA: CENCS-IA-92-97-ED-GH
BORING NO.	92-169 MU
SAMPLE NO.	W-1
DEPTH/ELEV	12.5'-14.5'
MRD LAB NO.	1535

FIGURE 2

FIGURE D-234

R

Table 1 - Triaxial $\bar{R}$ Test Results

Project : CHASKA; CENCS-IA-92-97-ED-GH
Boring Number : 92-169 MU
Sample Number : W-1
Depth : 12.5'-14.5'
Confining Pressure : .5 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.34	0.190	0.055	1.429	0.292	0.492	0.082
30	0.34	0.249	0.065	1.573	0.260	0.497	0.108
45	0.68	0.296	0.070	1.689	0.236	0.503	0.128
60	0.68	0.348	0.068	1.805	0.195	0.518	0.150
90	1.02	0.387	0.066	1.890	0.170	0.530	0.167
120	1.36	0.420	0.060	1.953	0.143	0.544	0.181
150	1.36	0.456	0.058	2.030	0.127	0.555	0.197
180	1.70	0.523	0.042	2.143	0.082	0.587	0.226
210	2.04	0.581	0.028	2.231	0.049	0.616	0.251
240	2.38	0.633	0.014	2.302	0.022	0.643	0.273
300	2.72	0.683	-0.002	2.360	-0.003	0.671	0.295
360	3.40	0.719	-0.018	2.388	-0.025	0.696	0.310
420	3.75	0.760	-0.035	2.419	-0.046	0.723	0.328
480	4.43	0.840	-0.061	2.497	-0.072	0.769	0.363
540	5.11	0.908	-0.089	2.541	-0.098	0.814	0.392
600	5.79	0.961	-0.117	2.557	-0.122	0.855	0.415
720	6.81	1.000	-0.143	2.554	-0.143	0.891	0.431
840	7.49	1.044	-0.168	2.563	-0.160	0.926	0.451
960	8.85	1.072	-0.205	2.521	-0.191	0.971	0.463
1080	10.55	1.020	-0.223	2.411	-0.218	0.976	0.440
1200	11.92	0.977	-0.215	2.367	-0.219	0.957	0.421
1320	13.62	0.875	-0.209	2.234	-0.238	0.926	0.378
1417	15.00	0.786	-0.174	2.165	-0.221	0.869	0.339
1417	15.00	0.786	-0.174	2.165	-0.221	0.869	0.339

Table 2 - Triaxial $\overline{R}$ Test Results

Project : CHASKA; CENCS-IA-92-97-ED-GH
Boring Number : 92-169 MU
Sample Number : W-1
Depth : 12.5'-14.5'
Confining Pressure : 1 TSF

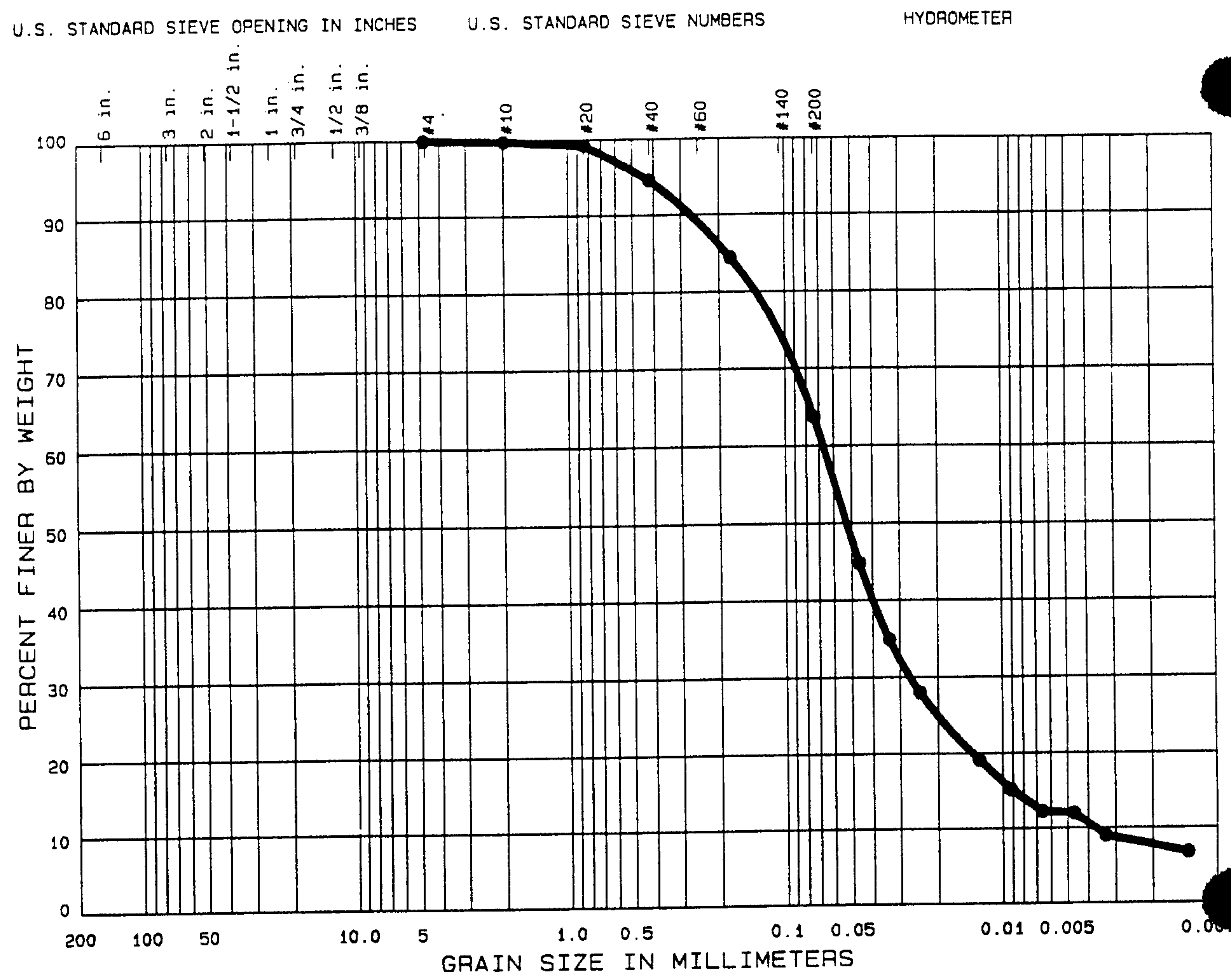
Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.34	0.318	0.037	1.330	0.116	1.042	0.137
30	0.34	0.397	0.042	1.414	0.106	1.056	0.171
45	0.68	0.529	0.094	1.584	0.177	1.037	0.228
60	0.68	0.925	0.269	2.265	0.291	0.960	0.399
90	1.03	1.090	0.397	2.806	0.365	0.873	0.470
120	1.37	1.190	0.459	3.197	0.386	0.836	0.513
150	1.37	1.272	0.503	3.561	0.396	0.812	0.549
180	1.71	1.400	0.528	3.965	0.377	0.819	0.604
210	2.05	1.517	0.537	4.278	0.354	0.839	0.655
240	2.40	1.615	0.536	4.483	0.333	0.864	0.697
300	2.74	1.716	0.528	4.634	0.308	0.897	0.741
360	3.42	1.797	0.516	4.710	0.287	0.929	0.776
420	3.77	1.887	0.496	4.745	0.263	0.971	0.815
480	4.45	2.046	0.463	4.811	0.227	1.044	0.883
540	5.14	2.198	0.415	4.756	0.189	1.129	0.949
600	5.82	2.301	0.364	4.620	0.159	1.206	0.993
720	6.85	2.413	0.323	4.562	0.134	1.274	1.041
840	7.53	2.535	0.282	4.528	0.112	1.345	1.094
960	8.90	2.731	0.193	4.384	0.071	1.483	1.179
1080	10.62	2.887	0.096	4.196	0.034	1.619	1.246
1200	11.99	3.029	0.030	4.121	0.010	1.720	1.307
1320	13.70	3.119	-0.062	3.938	-0.019	1.834	1.346
1411	15.00	3.183	-0.094	3.911	-0.029	1.882	1.374
1411	15.00	3.183	-0.094	3.911	-0.029	1.882	1.374

Table 3 - Triaxial $\bar{R}$ Test Results

Project : CHASKA; CENCS-IA-92-97-ED-GH
Boring Number : 92-169 MU
Sample Number : W-1
Depth : 12.5'-14.5'
Confining Pressure : 2 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.34	0.003	0.082	1.001	30.841	1.919	0.001
30	0.34	0.434	0.106	1.229	0.244	2.001	0.187
45	0.69	0.787	0.277	1.457	0.353	1.918	0.340
60	0.69	1.250	0.519	1.844	0.416	1.791	0.540
90	1.03	1.517	0.732	2.196	0.483	1.644	0.655
120	1.38	1.681	0.860	2.475	0.512	1.556	0.726
150	1.38	1.796	0.957	2.722	0.533	1.488	0.775
180	1.72	1.973	1.047	3.070	0.531	1.442	0.852
210	2.07	2.091	1.101	3.326	0.527	1.417	0.903
240	2.41	2.199	1.129	3.525	0.514	1.415	0.949
300	2.75	2.288	1.143	3.670	0.500	1.423	0.987
360	3.44	2.358	1.147	3.765	0.487	1.437	1.018
420	3.79	2.431	1.142	3.833	0.470	1.460	1.049
480	4.48	2.555	1.125	3.919	0.441	1.508	1.103
540	5.16	2.659	1.093	3.932	0.412	1.565	1.148
600	5.85	2.720	1.056	3.880	0.389	1.617	1.174
720	6.88	2.779	1.027	3.858	0.370	1.661	1.200
840	7.57	2.846	0.999	3.843	0.351	1.706	1.229
960	8.95	2.888	0.942	3.729	0.327	1.773	1.246
1080	10.67	2.889	0.895	3.615	0.310	1.820	1.247
1200	12.05	2.972	0.886	3.668	0.299	1.850	1.283
1320	13.77	2.992	0.816	3.527	0.273	1.925	1.292
1405	15.00	2.934	0.860	3.575	0.294	1.866	1.266
1405	15.00	2.934	0.860	3.575	0.294	1.866	1.266

W.O. No. CH92169
Req. No. CENCS-IA-92-97-ED-GH
Contract No.



% COBBLES		% GRAVEL	% SAND	% SILT OR CLAY	
●	0.0	0.0	36.2	51.8	12.0

	Sample No.	Elev or Depth	Nat W%	LL	PL	PI	C_c	C_u
●	S-1	12.5'-14.5'		23	19	4	2.95	18.2

CLASSIFICATION

● SANDY SILT, ML
SPECIFIC GRAVITY = 2.69

Remarks:

Project CHASKA FLOOD CONTROL

Lab No. 1535

Area

Boring No. 92-169 MU Date 7/28/92

GRADATION CURVES

CORPS OF ENGINEERS, MISSOURI RIVER DIVISION LAB
420 SOUTH 18th STREET - OMAHA, NE 68102-2586

Figure 2 FIG D-238

CLASSIFICATION TEST REQUEST

PROJECT: Chaska | MRD LAB. NO.:

ACCOMPANYING TEST: Q, $\overline{R}$ | REQUEST NO.:

CONTAINER - TYPE: Tube | NO.:

SAMPLE IDENTIFICATION: 92-169 MV S-1 12.5'-14.5'

SAMPLE IDENTIFICATION:

Structure: ( ) Brittle (✓) Plastic ( )

Consistency: Undisturbed (✓) Soft ( ) Med ( ) Stiff ( ) Hard

Remolded ( ) Insensitive (✓) Sl. Sens. ( ) Sensitive

PL Thread: Strength (✓) Low ( ) Med ( ) High ( )

Shine (✓) None ( ) Dull ( ) Gloss ( ) H. Gloss ( )

Shake Test ( ) None ( ) Slow ( ) Fast ( ) Rapid ( )

Torvane: .06 TSF

Color: grey

Disturbance:

Est. Max. Particle Size:

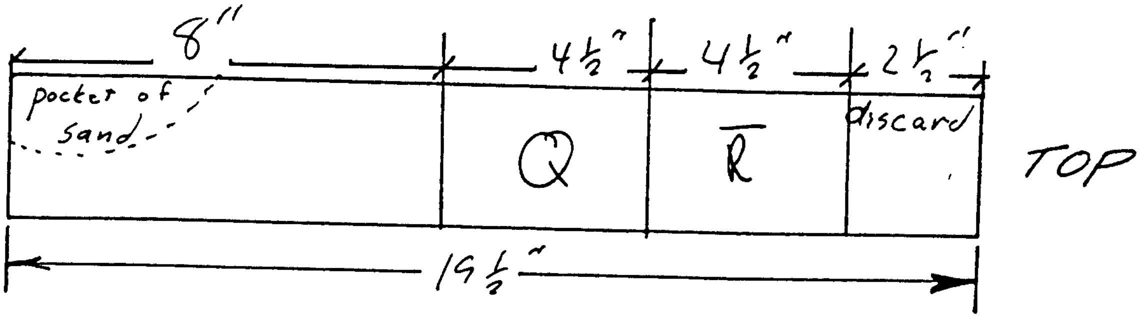
Remarks: lots of free surface water, Super saturated soil
Soil consolidates under its own weight

Odor: none

Cementation: none

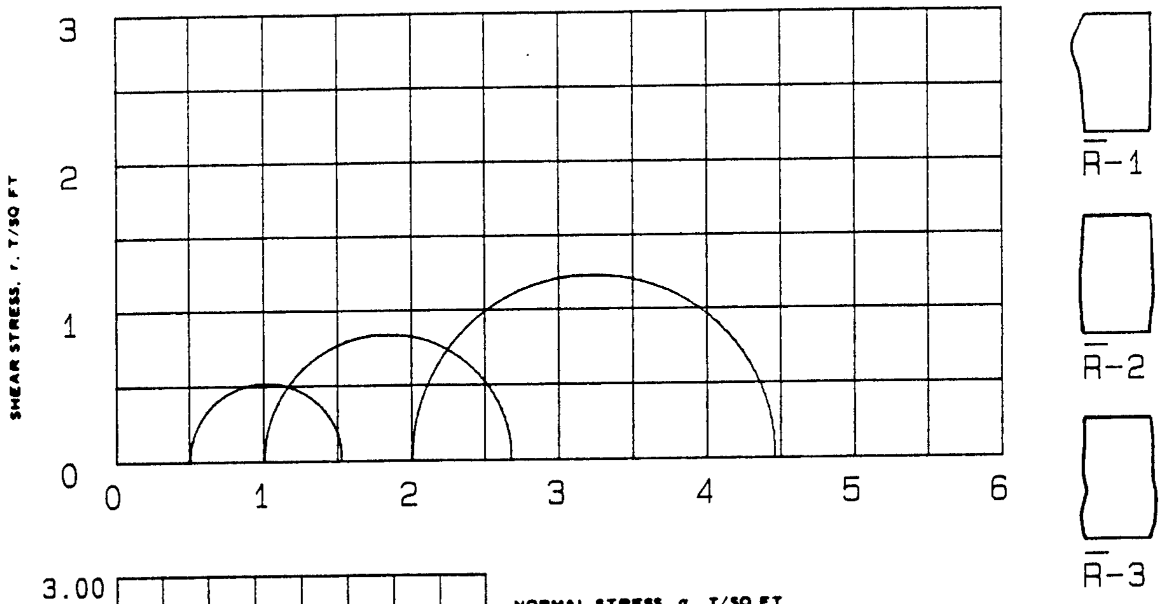
Date Core Opened: July 2, 1992

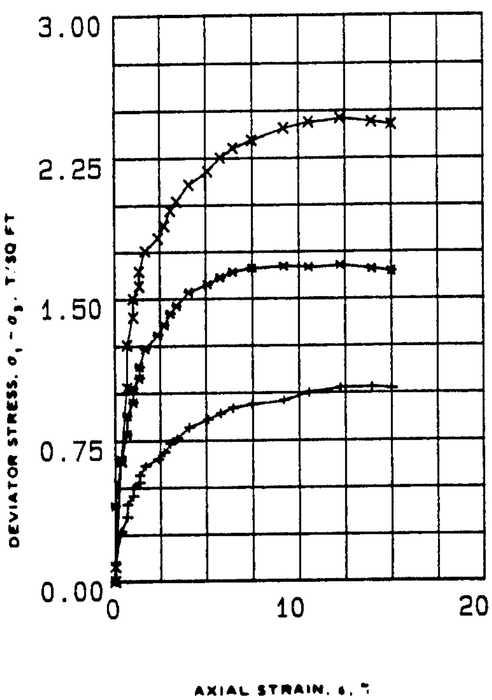
Sketch: (Core description and specimen location)



Technician [signature]

FIGURE D-239





SPECIMEN NO.		1 (+)	2 (*)	3 (X)
INITIAL — WATER CONTENT, %	w_o	22.2	23	21.5
INITIAL — DRY DENSITY LB/CU FT	γ_{d_o}	102.7	100.4	102.2
INITIAL — SATURATION, %	S_o	98	96	94
INITIAL — VOID RATIO	e_o	.59	.63	.6
BEFORE SHEAR — WATER CONTENT, %	w_c	20.4	21.3	19.6
BEFORE SHEAR — DRY DENSITY LB/CU FT	γ_{d_c}	106.6	105.5	108.3
BEFORE SHEAR — SATURATION, %	S_c	100	100	100
BEFORE SHEAR — VOID RATIO	e_c	.53	.55	.51
BEFORE SHEAR — FINAL BACK PRESSURE, T/SQ FT	u_o	3.383	3.383	3.383
MINOR PRINCIPAL STRESS, T/SQ FT	σ_3	.5	1	2
MAXIMUM DEVIATOR STRESS, T/SQ FT	$(\sigma_1 - \sigma_3)_{max}$	1.028	1.676	2.459
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN	t_f	1320	1200	1200
ULTIMATE DEVIATOR STRESS, T/SQ FT	$(\sigma_1 - \sigma_3)_{ult}$	1.019	1.644	2.426
INITIAL DIAMETER, IN.	D_o	1.44	1.42	1.42
INITIAL HEIGHT, IN.	H_o	2.98	2.99	3
B-Value		1.0	1.0	1.0

CONTROLLED-STRAIN TEST

DESCRIPTION OF SPECIMENS Clayey Sand, SC

LL 35 | PL 14 | PI 21 | G_s 2.62

TYPE OF SPECIMEN UNDISTURBED | TYPE OF TEST RBAR

REMARKS: Black, soft, organic, non-calcareous. Torvane=0.20 TSF.

PROJECT CHASKA; CENCS-IA-92-97-ED-GH

BORING NO 92-171 MU | SAMPLE NO. W-1

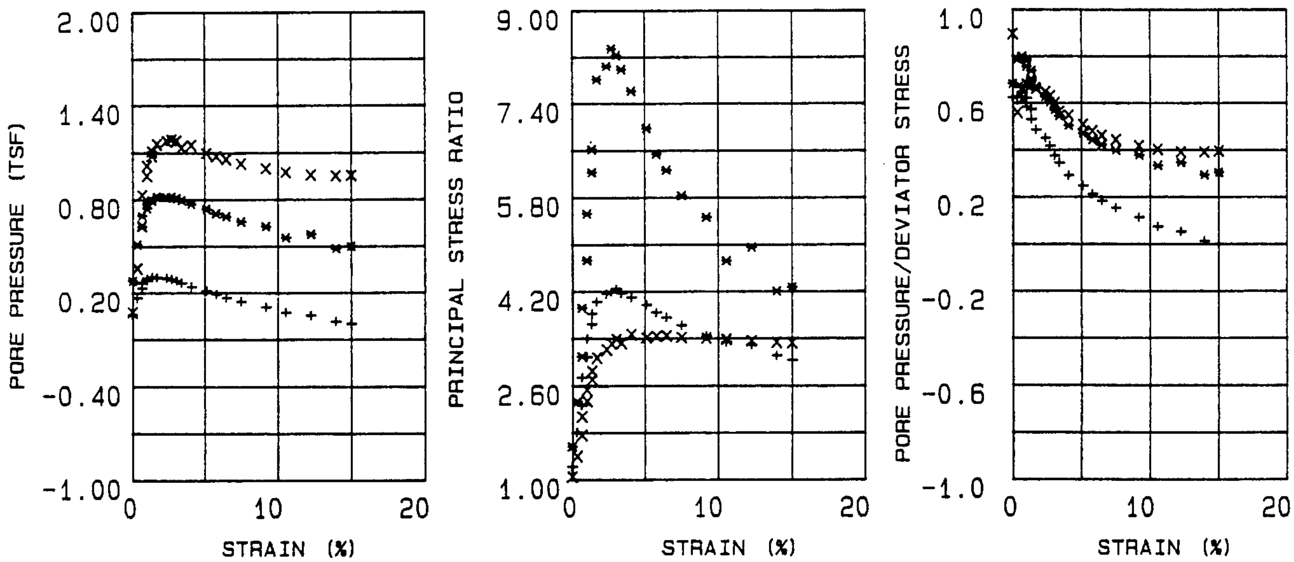
DEPTH ELEV 24'-26'

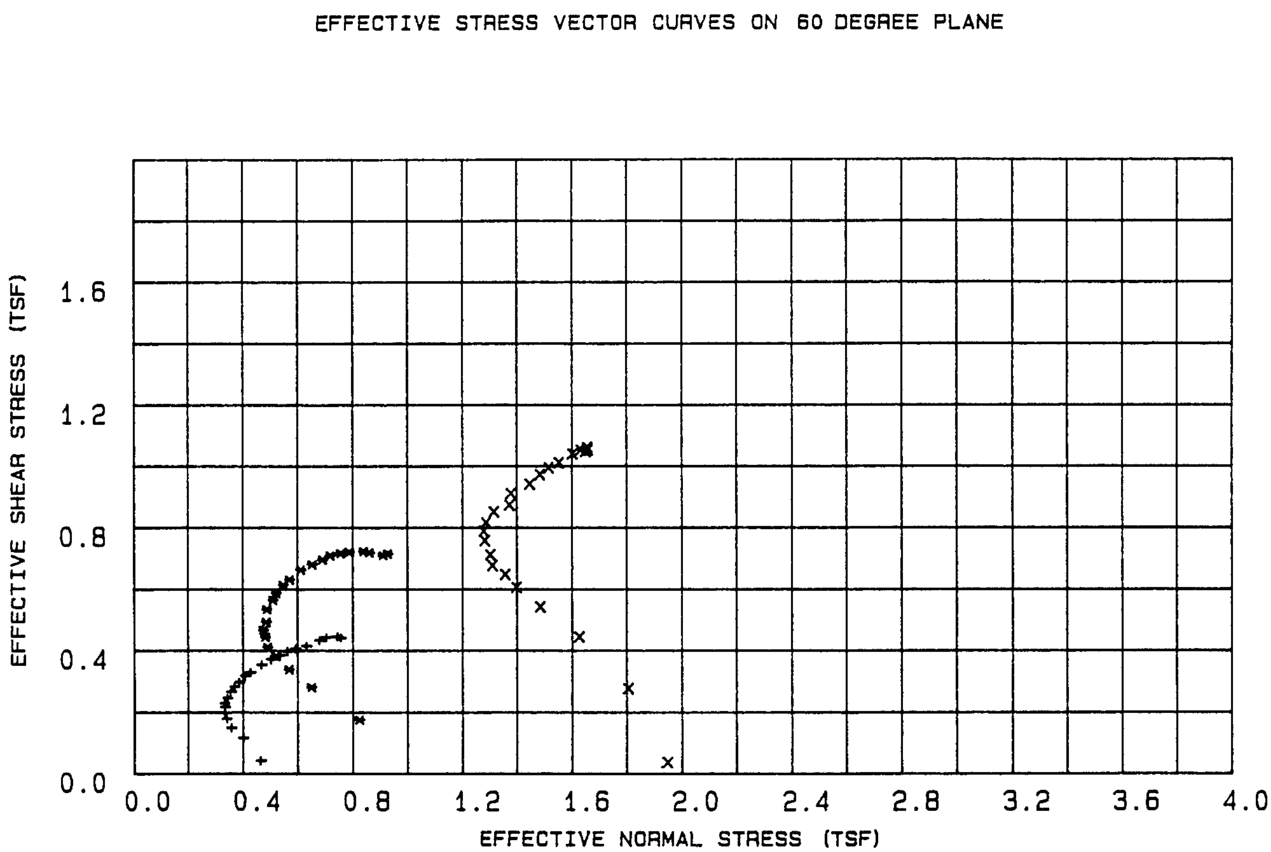
LABORATORY 1535 | DATE 07-23-92

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE | TRANSLUCENT | (EM 1110-2-1906)

FIGURE 3





LEGEND

+ = .5 TSF
* = 1 TSF
X = 2 TSF

PROJECT	CHASKA; CENCS-IA-92-97-ED-GH
BORING NO.	92-171 MU
SAMPLE NO.	W-1
DEPTH/ELEV	24'-26'
MRD LAB NO.	1535

FIGURE 4

FIGURE D-241

R

Table 4 - Triaxial $\bar{R}$ Test Results

Project : CHASKA; CENCS-IA-92-97-ED-GH
Boring Number : 92-171 MU
Sample Number : W-1
Depth : 24'-26'
Confining Pressure : .5 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.00	0.094	0.058	1.213	0.622	0.465	0.041
30	0.34	0.267	0.166	1.799	0.624	0.400	0.115
45	0.68	0.344	0.229	2.268	0.667	0.356	0.148
60	0.68	0.411	0.264	2.744	0.643	0.338	0.177
90	1.02	0.456	0.282	3.087	0.618	0.331	0.197
120	1.02	0.501	0.291	3.395	0.581	0.333	0.216
150	1.36	0.527	0.300	3.639	0.570	0.331	0.228
180	1.36	0.568	0.299	3.821	0.527	0.342	0.245
210	1.70	0.616	0.297	4.029	0.482	0.355	0.266
240	2.38	0.654	0.293	4.161	0.448	0.369	0.282
300	2.72	0.688	0.284	4.193	0.414	0.386	0.297
360	3.06	0.735	0.274	4.249	0.372	0.408	0.317
420	3.40	0.761	0.260	4.168	0.342	0.428	0.328
480	4.08	0.818	0.235	4.093	0.288	0.468	0.353
540	5.10	0.860	0.210	3.970	0.245	0.503	0.371
600	5.78	0.891	0.186	3.834	0.209	0.535	0.384
720	6.46	0.920	0.165	3.746	0.180	0.563	0.397
840	7.48	0.938	0.140	3.610	0.150	0.592	0.405
960	9.18	0.959	0.105	3.428	0.110	0.632	0.414
1080	10.54	1.000	0.069	3.322	0.070	0.679	0.432
1200	12.24	1.025	0.050	3.276	0.049	0.704	0.442
1320	13.94	1.028	0.010	3.098	0.010	0.744	0.444
1395	15.00	1.019	-0.004	3.022	-0.004	0.757	0.440

Table 5 - Triaxial $\bar{R}$ Test Results

Project : CHASKA; CENCS-IA-92-97-ED-GH
Boring Number : 92-171 MU
Sample Number : W-1
Depth : 24'-26'
Confining Pressure : 1 TSF

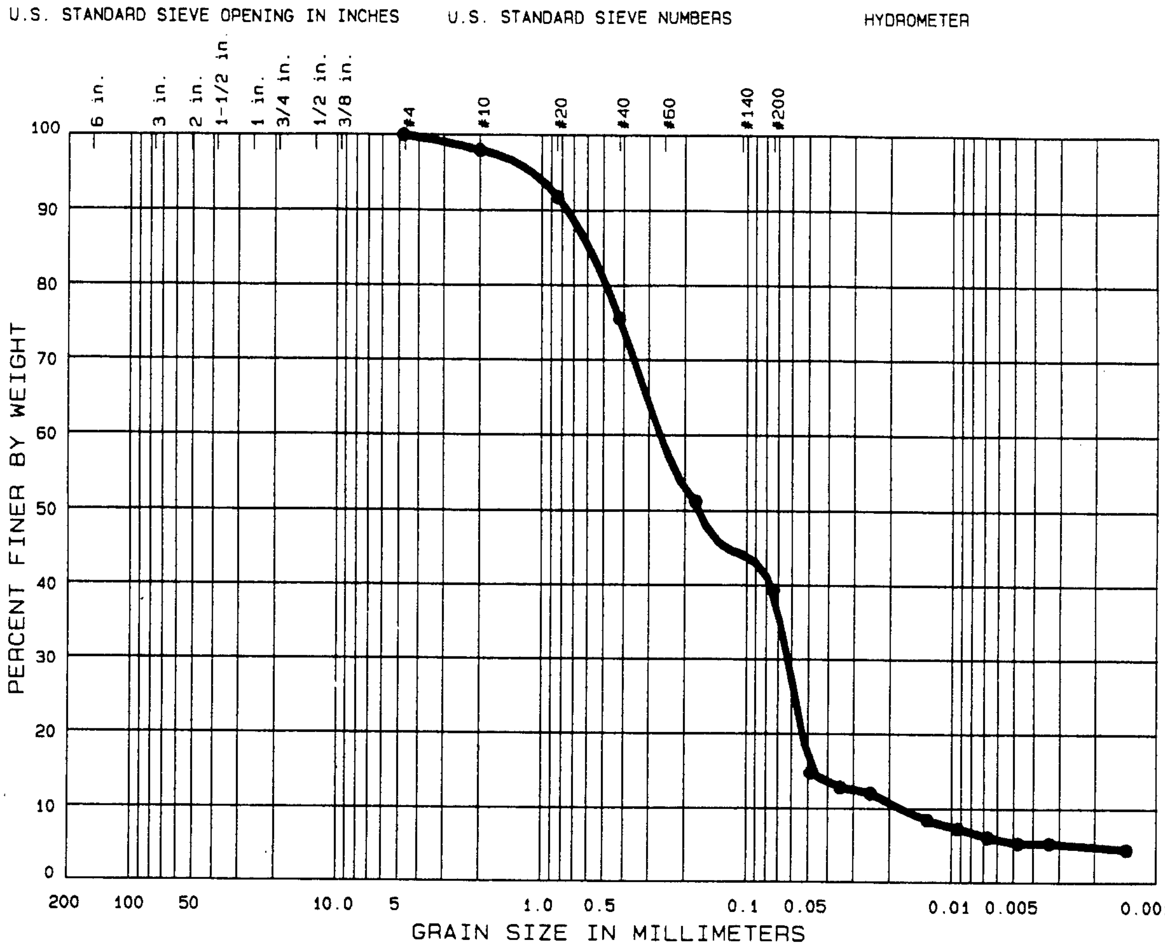
Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.00	0.404	0.275	1.558	0.681	0.825	0.174
30	0.34	0.649	0.511	2.327	0.788	0.650	0.280
45	0.68	0.784	0.626	3.098	0.800	0.568	0.338
60	0.68	0.882	0.698	3.919	0.791	0.520	0.381
90	1.02	0.951	0.745	4.732	0.784	0.490	0.410
120	1.02	1.026	0.773	5.523	0.755	0.481	0.443
150	1.36	1.079	0.793	6.225	0.736	0.474	0.466
180	1.36	1.140	0.797	6.616	0.700	0.485	0.492
210	1.70	1.235	0.819	7.808	0.664	0.487	0.533
240	2.38	1.307	0.814	8.039	0.624	0.510	0.564
300	2.72	1.359	0.815	8.348	0.600	0.521	0.587
360	3.06	1.420	0.804	8.225	0.567	0.547	0.613
420	3.40	1.462	0.791	7.978	0.541	0.571	0.631
480	4.08	1.535	0.768	7.604	0.500	0.612	0.663
540	5.10	1.576	0.736	6.967	0.467	0.654	0.680
600	5.78	1.612	0.708	6.529	0.440	0.691	0.696
720	6.46	1.642	0.688	6.256	0.419	0.719	0.709
840	7.49	1.662	0.655	5.821	0.395	0.757	0.717
960	9.19	1.671	0.625	5.455	0.375	0.789	0.721
1080	10.55	1.666	0.552	4.716	0.331	0.861	0.719
1200	12.25	1.676	0.575	4.946	0.344	0.840	0.723
1320	13.95	1.655	0.482	4.193	0.292	0.928	0.714
1394	15.00	1.644	0.496	4.262	0.302	0.911	0.709

Table 6 - Triaxial $\overline{R}$ Test Results

Project : CHASKA; CENCS-IA-92-97-ED-GH
Boring Number : 92-171 MU
Sample Number : W-1
Depth : 24'-26'
Confining Pressure : 2 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.00	0.080	0.072	1.042	0.896	1.948	0.035
30	0.34	0.641	0.355	1.389	0.555	1.804	0.276
45	0.68	1.027	0.629	1.749	0.613	1.625	0.443
60	0.68	1.253	0.827	2.069	0.661	1.483	0.541
90	1.02	1.401	0.950	2.334	0.678	1.397	0.605
120	1.02	1.500	1.015	2.523	0.677	1.356	0.647
150	1.36	1.567	1.079	2.700	0.689	1.309	0.676
180	1.36	1.646	1.107	2.844	0.673	1.301	0.711
210	1.70	1.754	1.153	3.070	0.658	1.281	0.757
240	2.38	1.823	1.174	3.206	0.644	1.277	0.787
300	2.72	1.888	1.181	3.304	0.626	1.286	0.815
360	3.06	1.970	1.173	3.382	0.596	1.315	0.850
420	3.40	2.019	1.128	3.314	0.559	1.372	0.872
480	4.08	2.108	1.145	3.465	0.544	1.377	0.910
540	5.10	2.179	1.094	3.406	0.503	1.446	0.941
600	5.78	2.251	1.074	3.430	0.477	1.483	0.972
720	6.46	2.303	1.055	3.437	0.458	1.515	0.994
840	7.48	2.343	1.027	3.409	0.439	1.553	1.011
960	9.18	2.408	0.995	3.396	0.414	1.601	1.039
1080	10.54	2.439	0.972	3.373	0.399	1.632	1.053
1200	12.24	2.459	0.954	3.351	0.388	1.655	1.061
1320	13.94	2.439	0.948	3.319	0.389	1.656	1.053
1394	15.00	2.426	0.952	3.314	0.393	1.649	1.047

W.O. No. 15351711
Req. No. 92-97-ED-GH
Contract No.



	% COBBLES	% GRAVEL	% SAND	% SILT OR CLAY	
●	0.0	0.0	60.6	34.0	5.4

	Sample No.	Elev or Depth	Nat W%	LL	PL	PI	C_c	C_u
●	W-1	24.0'-26.0'		35	14	21	0.86	15.1

CLASSIFICATION

● CLAYEY SAND, SC
SPECIFIC GRAVITY = 2.62

Remarks:

Project CHASKA FLOOD CONTROL

Lab No. 1535

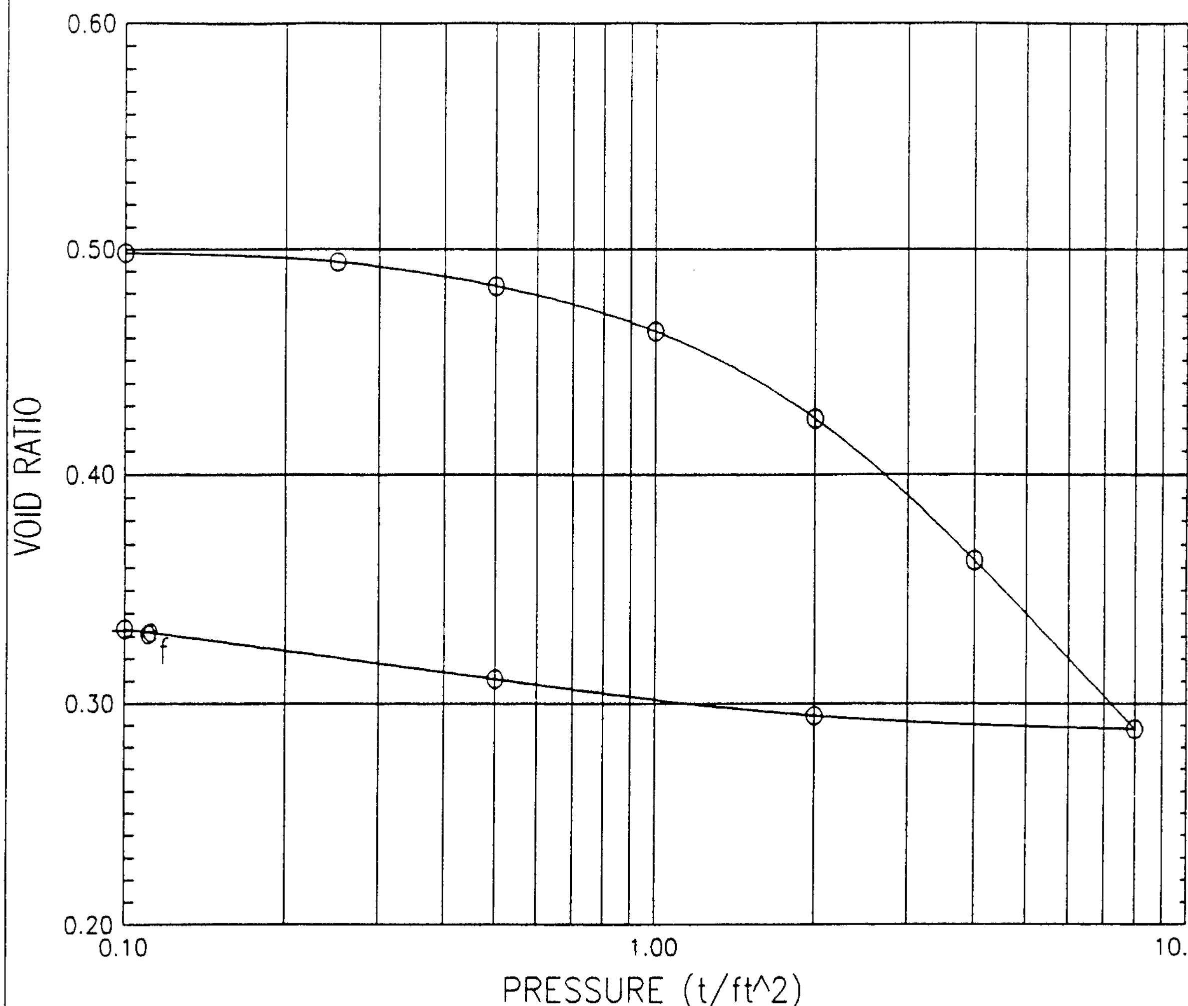
Area

Boring No. 92-171 MU   Date 8-5-92

GRADATION CURVES

CORPS OF ENGINEERS, MISSOURI RIVER DIVISION LAB
420 SOUTH 18th STREET - OMAHA, NE 68102-2586

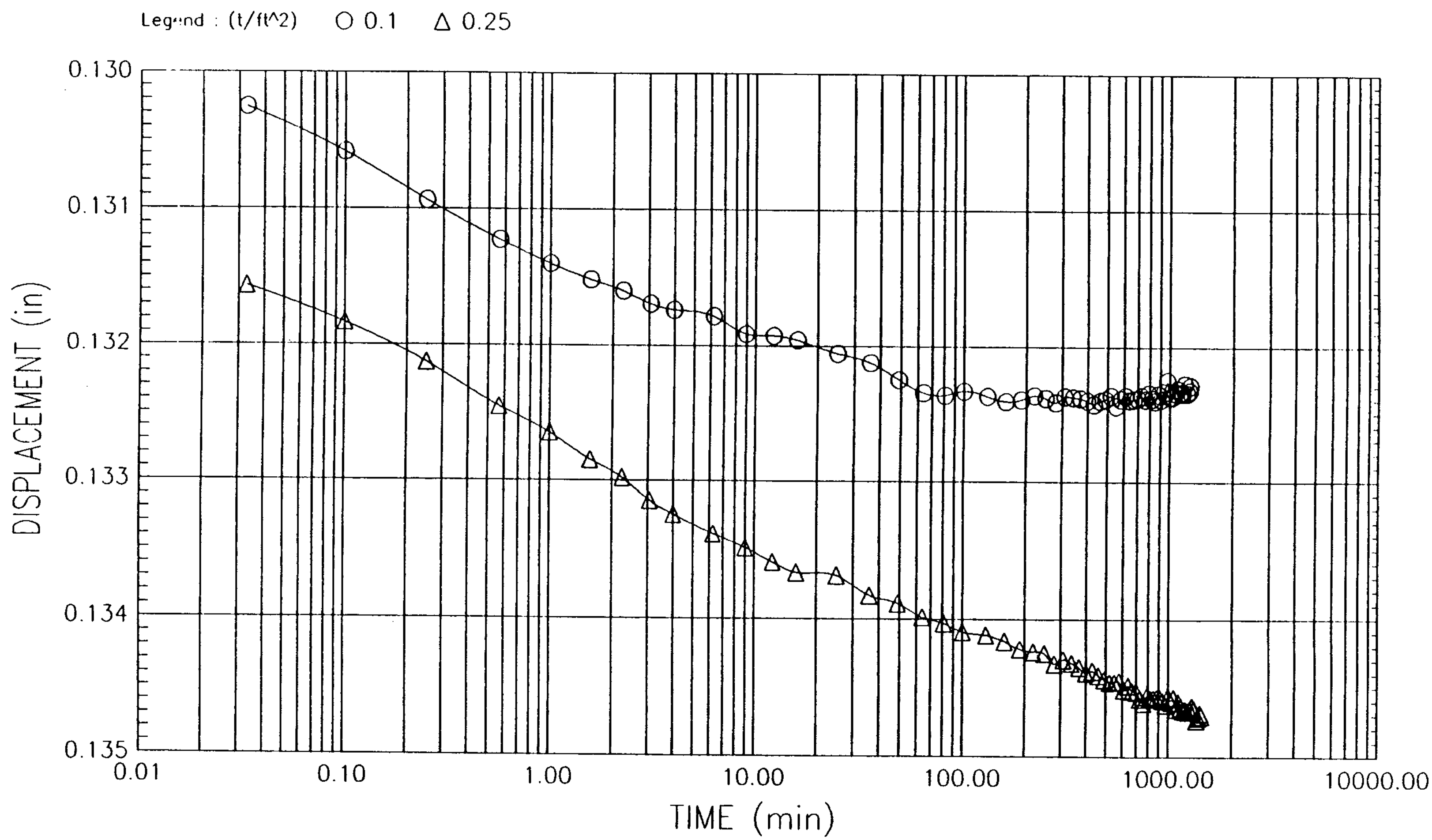
Figure 5 FIGURE D-245



			BEFORE TEST	AFTER TEST
OVERBURDEN PRESSURE (t/ft^2)		WATER CONTENT (%)	27.720	23.328
PRECONSOL. PRESSURE (t/ft^2)		DRY DENSITY (lb/ft^3)	93.996	121.746
COMPRESSION INDEX		SATURATION (%)	99.164	182.027
TYPE SPECIMEN		VOID RATIO	0.727	0.333
DIA. (in) 2.500	HT. (in) 1.000	BACK PRESSURE (t/ft^2)		
CLASSIFICATION Sandy Clay, CL				
LL 42	PL 14 PI 28	PROJECT CHASKA FLOOD CONTROL		
GS 2.600	D 10	Data File: LPT1		
REMARKS Dark gray. Torvane=0.45 TSF.		BORING NO. 92-171MU	SAMPLE NO. W-2	
		DEPTH 30'-32'	DATE 7/1/92	

USACE, MRD
CONSOLIDATION TEST REPORT

Figure 3



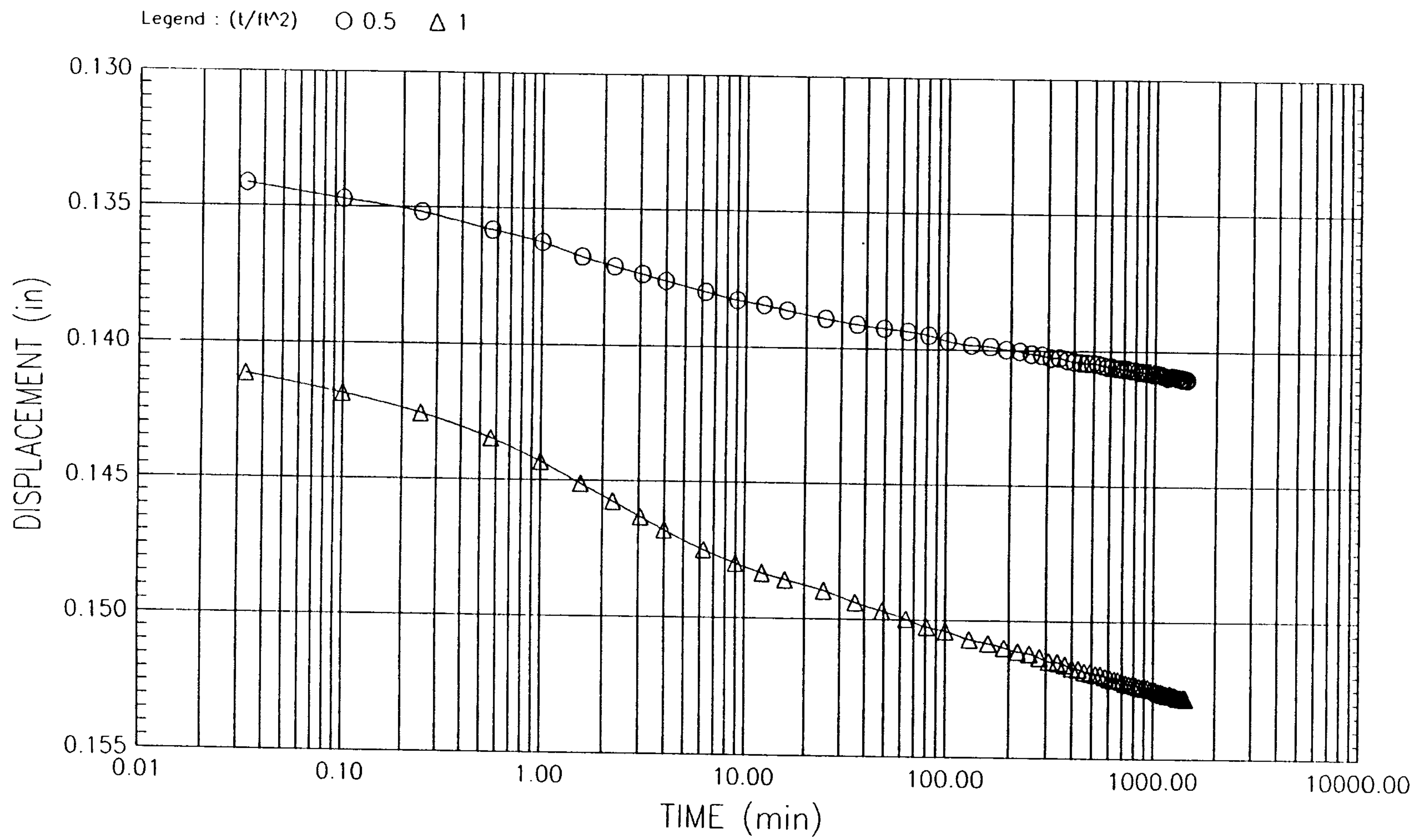
PROJECT	CHASKA FLOOD CONTROL		
	Data File: LPT1		
BORING	92-171MU	SAMPLE NO.	W-2
DEPTH	30'-32'	DATE	7/1/92

USACE, MRD

CONSOLIDATION TEST

TIME CURVES

Figure 4



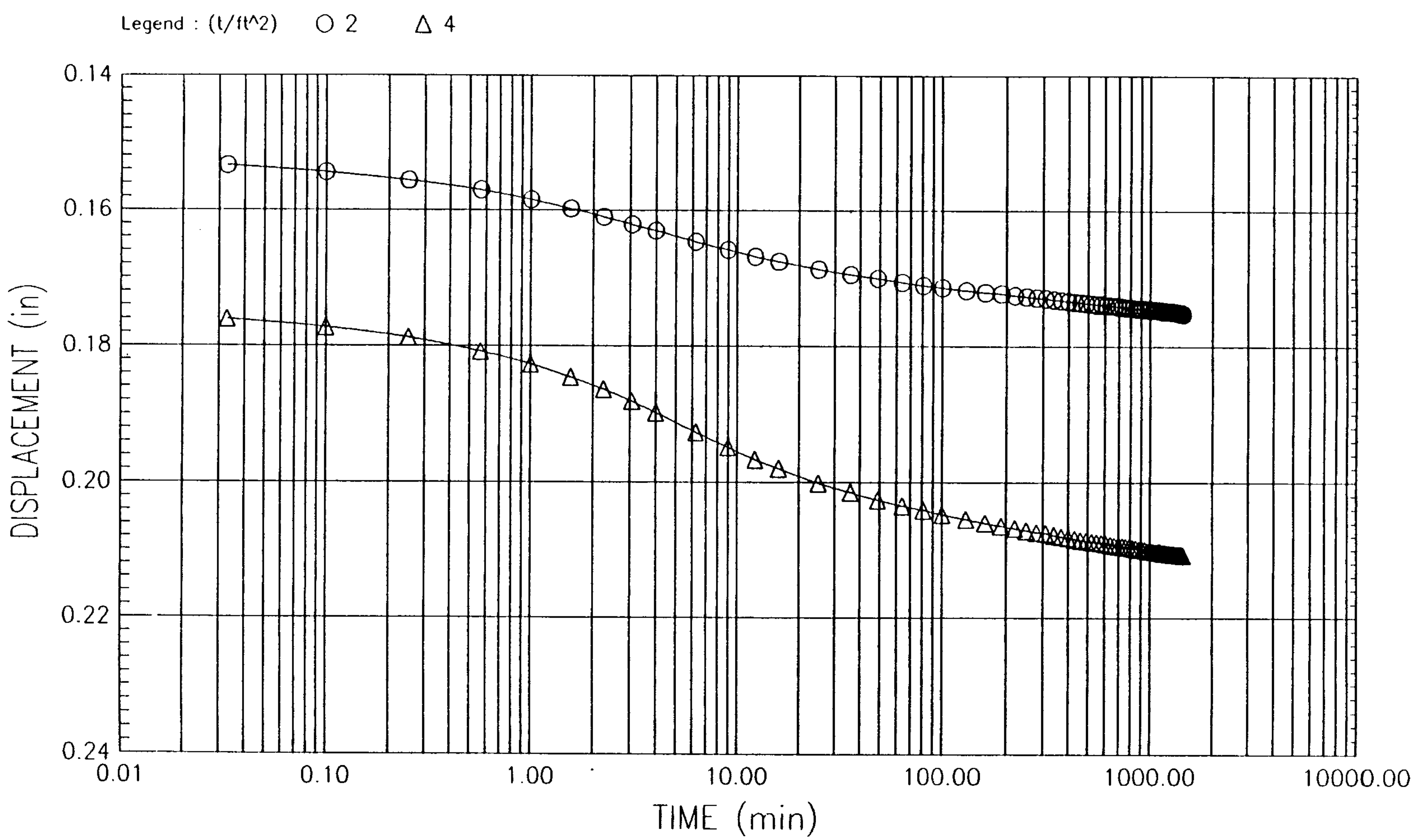
PROJECT	CHASKA FLOOD CONTROL		
	Data File: LPT1		
BORING	92-171MU	SAMPLE NO.	W-2
DEPTH	30'-32'	DATE	7/1/92

USACE, MRD

CONSOLIDATION TEST

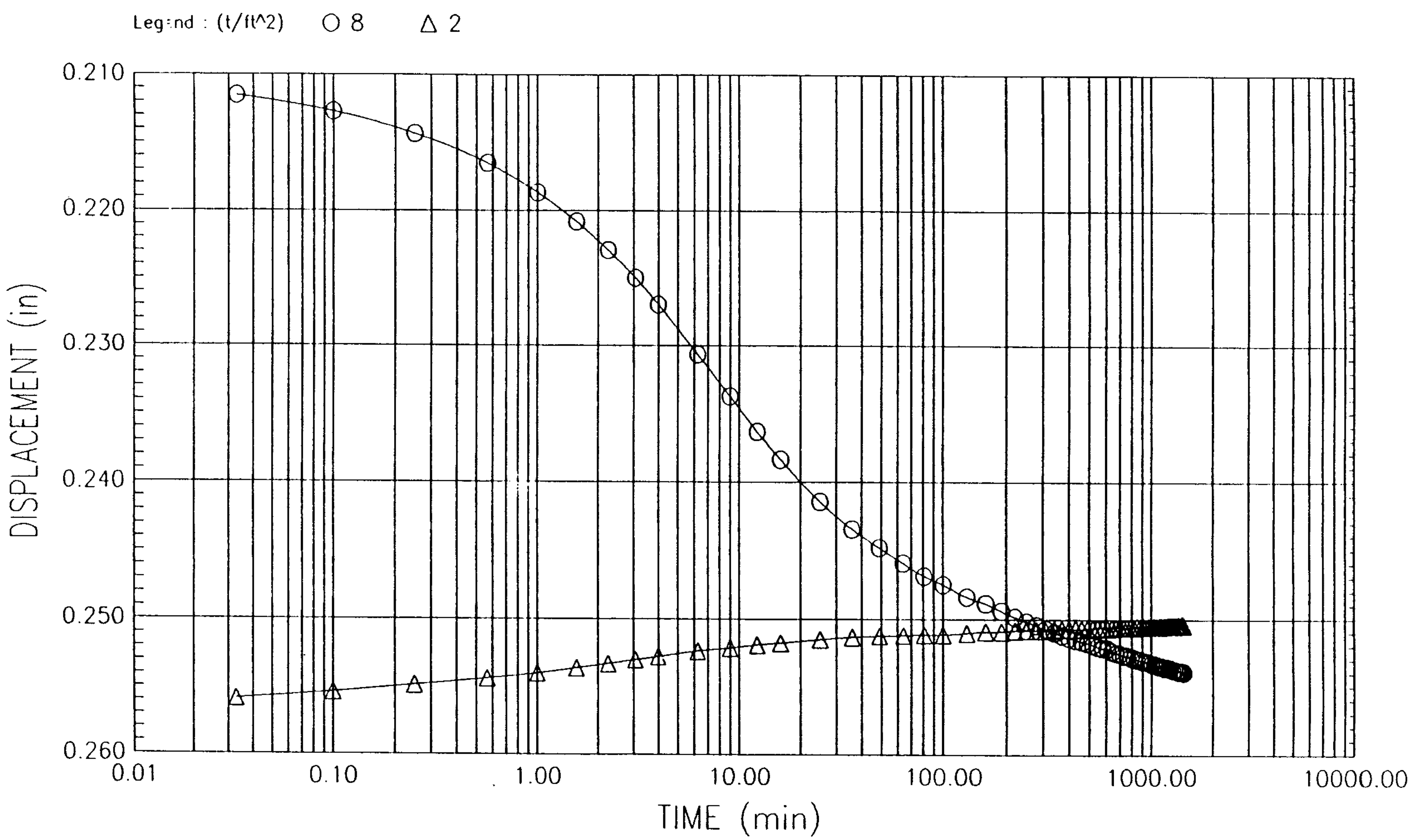
TIME CURVES

Figure 5



PROJECT	CHASKA FLOOD CONTROL			USACE, MRD CONSOLIDATION TEST TIME CURVES
	Data File: LPT1			
BORING	92-171MU	SAMPLE NO.	W-2	
DEPTH	30'-32'	DATE	7/1/92	

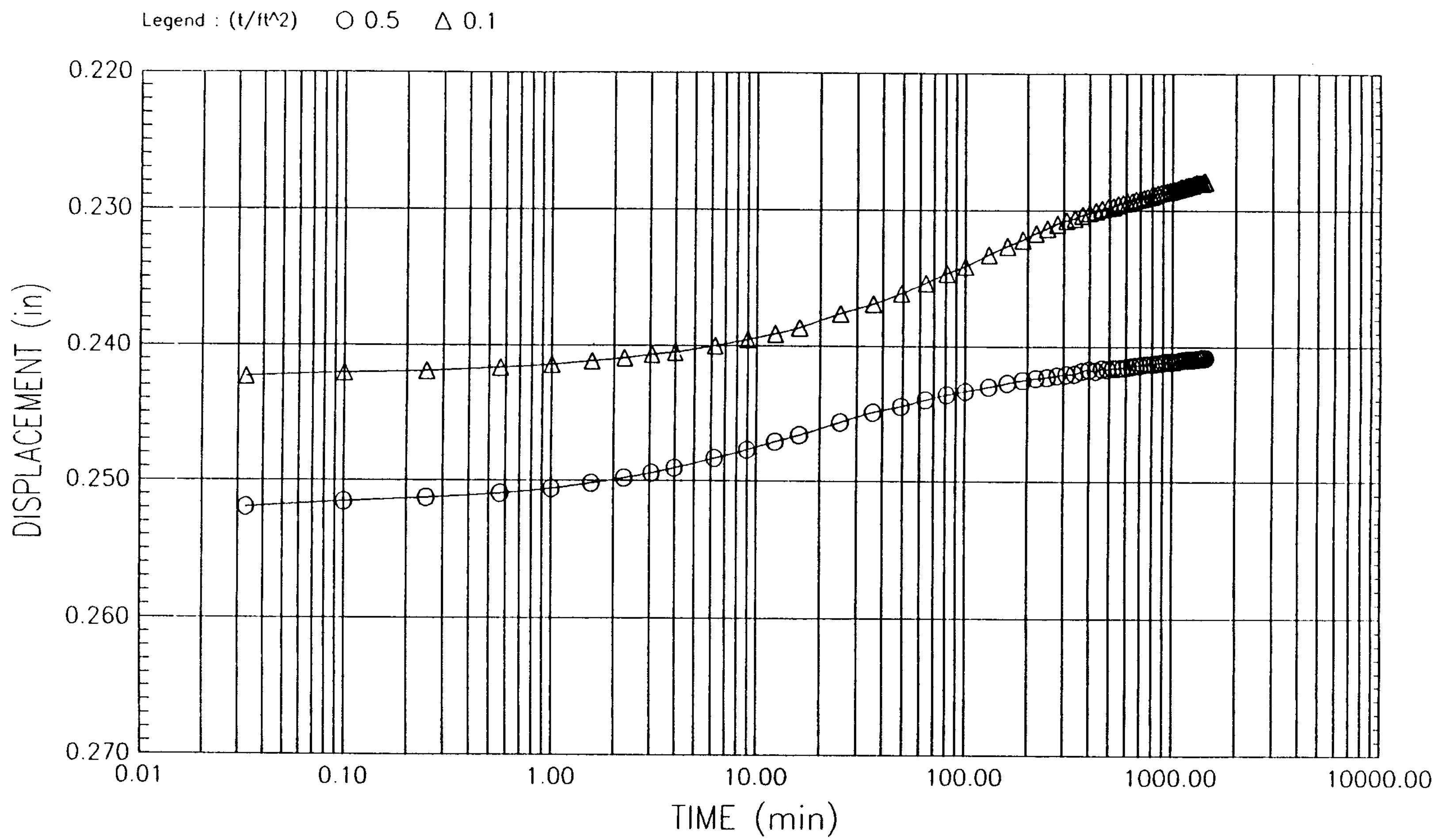
Figure 6



PROJECT	CHASKA FLOOD CONTROL		
	Data File: LPT1		
BORING	92-171MU	SAMPLE NO.	W-2
DEPTH	30'-32'	DATE	7/1/92

USACE, MRD
CONSOLIDATION TEST
TIME CURVES

Figure 7



PROJECT	CHASKA FLOOD CONTROL		
	Data File: LPT1		
BORING	92-171MU	SAMPLE NO.	W-2
DEPTH	30'-32'	DATE	7/1/92

USACE, MRD

CONSOLIDATION TEST

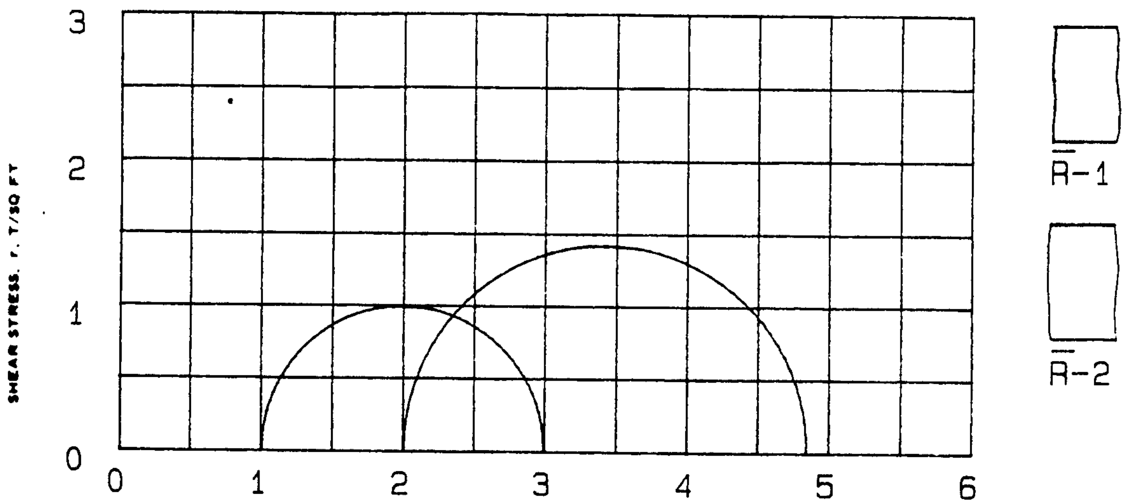
TIME CURVES

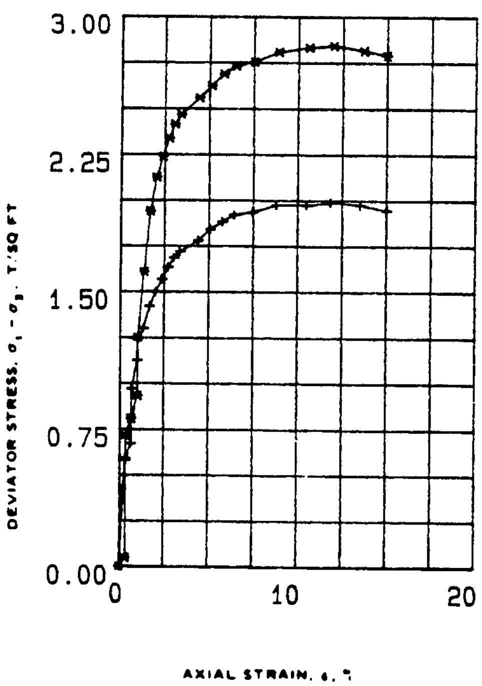
Figure 8

CONSOLIDATION TEST DATA

Project : CHASKA FLOOD CONTROL Location : Project No. : 1535
Test No. :
Boring No. : 92-171MU Test Date : 7/1/92 Tested by : MJW
Sample No. : W-2 Sample Type : UNDISTURB Depth : 30'-32'
Checked by :
Soil Description :
Remarks :

	APPLIED PRESSURE (t/ft^2)	FINAL DISPLACEMENT (in)	VOID RATIO	STRAIN AT END (%)	FITTING TIME (min)		COEFFICIENT OF CONSOLIDATION (in^2/s)		
					SQ.RT.	LOG	SQ.RT.	LOG	AVE
1)	0.10	0.132	0.498	13.23	3.4	0.0	2.10E-004	0.00E+000	0.00E+000
2)	0.25	0.135	0.494	13.47	13.5	0.0	4.58E-005	0.00E+000	0.00E+000
3)	0.50	0.141	0.483	14.10	10.7	0.0	5.71E-005	0.00E+000	0.00E+000
4)	1.00	0.153	0.463	15.28	10.4	0.0	5.77E-005	0.00E+000	0.00E+000
5)	2.00	0.175	0.424	17.52	7.9	0.0	7.27E-005	0.00E+000	0.00E+000
6)	4.00	0.211	0.363	21.07	7.8	0.0	6.82E-005	0.00E+000	0.00E+000
7)	8.00	0.254	0.288	25.39	7.3	0.0	6.62E-005	0.00E+000	0.00E+000
8)	2.00	0.250	0.294	25.04	3.8	0.0	1.20E-004	0.00E+000	0.00E+000
9)	0.50	0.241	0.311	24.08	17.4	0.0	2.68E-005	0.00E+000	0.00E+000
10)	0.10	0.228	0.333	22.79	53.6	0.0	8.98E-006	0.00E+000	0.00E+000





NORMAL STRESS, σ, T/SQ FT

			1 (+)	2 (*)		
SPECIMEN NO.			1 (+)	2 (*)		
INITIAL	WATER CONTENT, %	w_o	27.7	27.7		
INITIAL	DRY DENSITY LB/CU FT	γd_o	92.2	91.1		
INITIAL	SATURATION, %	S_o	95	92		
INITIAL	VOID RATIO	e_o	.76	.78		
BEFORE SHEAR	WATER CONTENT, %	w_c	26.7	25.1		
BEFORE SHEAR	DRY DENSITY LB/CU FT	γd_c	96.1	98.9		
BEFORE SHEAR	SATURATION, %	S_c	100	100		
BEFORE SHEAR	VOID RATIO	e_c	.69	.64		
BEFORE SHEAR	FINAL BACK PRESSURE, T/SQ FT	u_o	4.823	4.823		
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	1	2		
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	1.989	2.842		
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	1200	1200		
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	1.944	2.787		
INITIAL DIAMETER, IN.		D_o	1.46	1.46		
INITIAL HEIGHT, IN.		H_o	3	3		
B-Value			1.0	1.0		

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Sandy Clay, CL

LL	PL	PI	G_s	TYPE OF SPECIMEN	TYPE OF TEST
42	14	28	2.6	UNDISTURBED	RBAR

REMARKS: Dark gray. Non-calcareous.
Torvane=0.45 TSF.

PROJECT CHASKA; CENCS-IA-92-97-ED-GH

BORING NO 92-171 MU SAMPLE NO. W-2

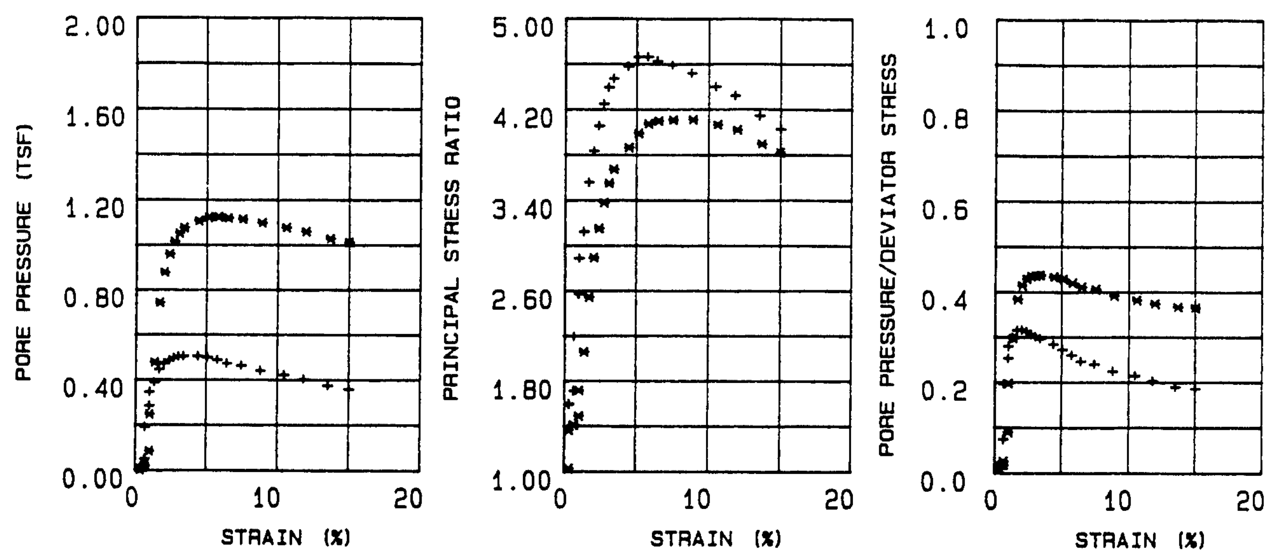
DEPTH ELEV 30'-32'

LABORATORY 1535 DATE 07-27-92

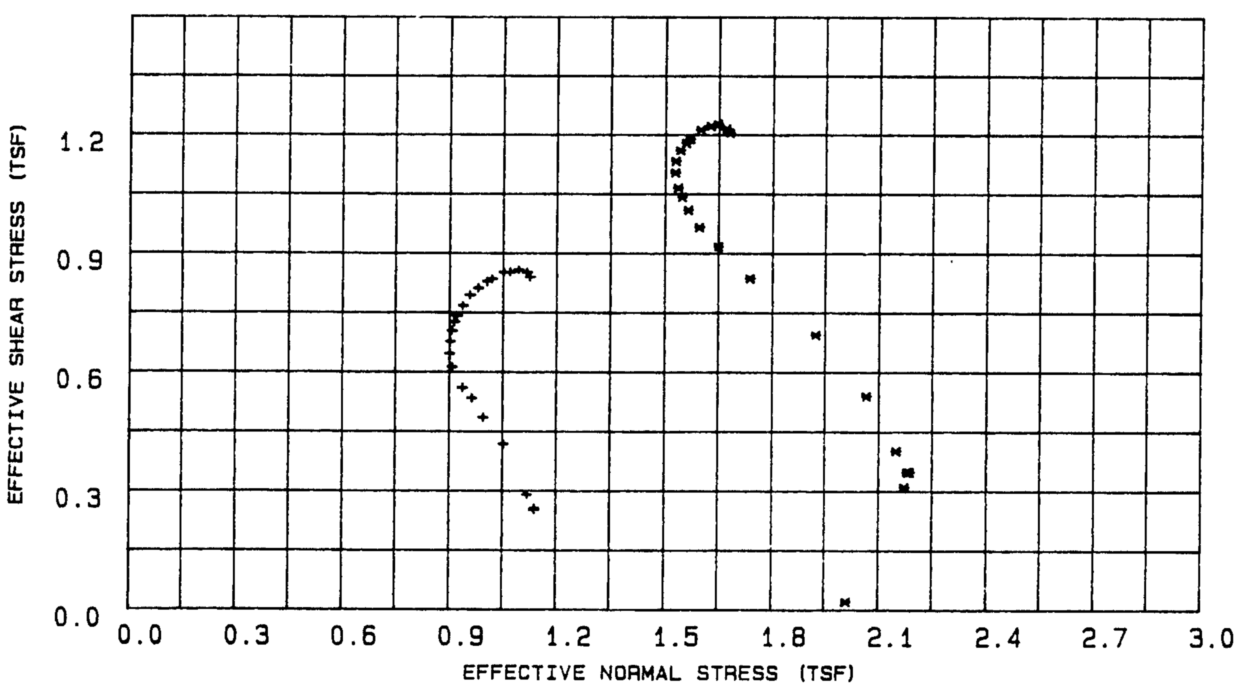
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

FIGURE 6



EFFECTIVE STRESS VECTOR CURVES ON 60 DEGREE PLANE



LEGEND

+ = 1 TSF

* = 2 TSF

PROJECT	CHASKA: CENCS-IA-92-97-ED-GH
BORING NO.	92-171 MU
SAMPLE NO.	W-2
DEPTH/ELEV	30'-32'
MRD LAB NO.	1535

FIGURE 7

Table 7 - Triaxial $\bar{R}$ Test Results

Project : CHASKA; CENCS-IA-92-97-ED-GH
Boring Number : 92-171 MU
Sample Number : W-2
Depth : 30'-32'
Confining Pressure : 1 TSF

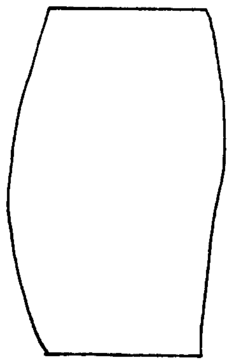
Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.34	0.590	0.007	1.594	0.013	1.139	0.255
30	0.34	0.581	0.006	1.585	0.010	1.138	0.251
45	0.68	0.673	0.049	1.708	0.073	1.118	0.290
60	0.68	0.968	0.189	2.194	0.196	1.051	0.418
90	1.01	1.124	0.284	2.569	0.253	0.994	0.485
120	1.01	1.238	0.344	2.887	0.279	0.962	0.534
150	1.35	1.300	0.387	3.120	0.298	0.935	0.561
180	1.69	1.419	0.445	3.556	0.314	0.906	0.612
210	2.03	1.497	0.472	3.834	0.315	0.899	0.646
240	2.37	1.567	0.487	4.053	0.311	0.901	0.676
300	2.70	1.632	0.498	4.247	0.305	0.906	0.704
360	3.04	1.683	0.504	4.393	0.300	0.913	0.726
420	3.38	1.717	0.505	4.471	0.295	0.920	0.741
480	4.39	1.778	0.503	4.575	0.283	0.937	0.767
540	5.07	1.839	0.498	4.660	0.271	0.957	0.794
600	5.75	1.882	0.486	4.662	0.259	0.980	0.812
720	6.42	1.920	0.470	4.624	0.245	1.005	0.829
840	7.44	1.935	0.461	4.588	0.239	1.018	0.835
960	8.79	1.974	0.438	4.516	0.223	1.051	0.852
1080	10.48	1.973	0.419	4.396	0.213	1.069	0.852
1200	11.83	1.989	0.400	4.316	0.202	1.092	0.858
1320	13.52	1.972	0.372	4.138	0.189	1.116	0.851
1424	15.00	1.944	0.356	4.021	0.184	1.125	0.839

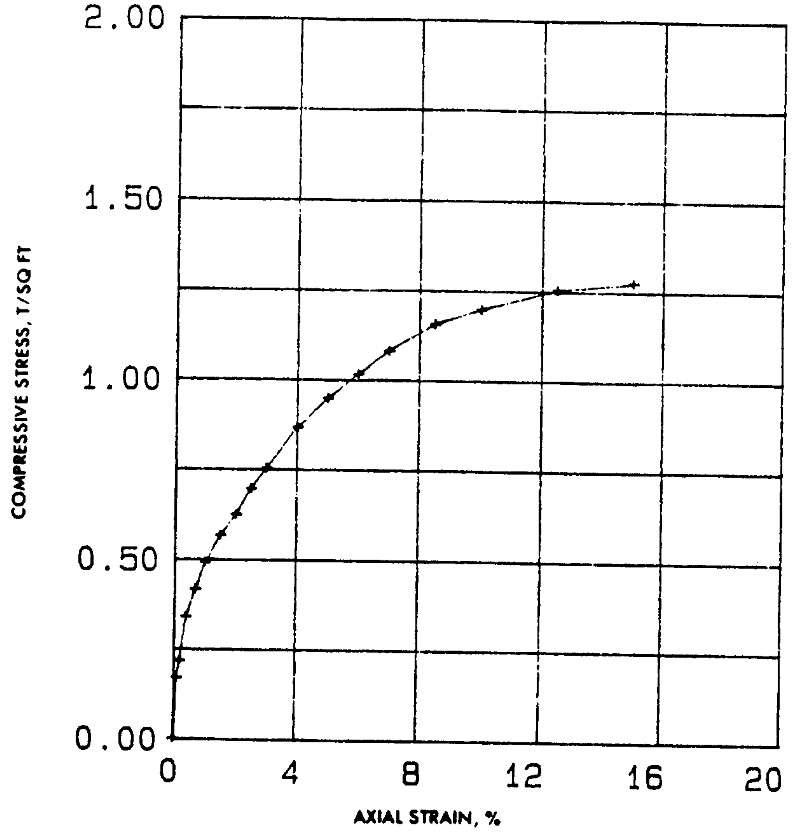
Table 8 - Triaxial $\bar{R}$ Test Results

Project : CHASKA; CENCS-IA-92-97-ED-GH
Boring Number : 92-171 MU
Sample Number : W-2
Depth : 30'-32'
Confining Pressure : 2 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.34	0.047	0.001	1.023	0.016	2.011	0.020
30	0.34	0.718	0.006	1.360	0.009	2.172	0.310
45	0.68	0.807	0.014	1.406	0.017	2.186	0.348
60	0.68	0.807	0.020	1.408	0.025	2.180	0.348
90	1.03	0.932	0.083	1.486	0.089	2.148	0.402
120	1.03	1.252	0.246	1.714	0.197	2.064	0.540
150	1.37	1.608	0.476	2.055	0.297	1.922	0.694
180	1.71	1.939	0.743	2.542	0.384	1.737	0.837
210	2.05	2.125	0.878	2.894	0.414	1.648	0.917
240	2.40	2.238	0.959	3.150	0.429	1.595	0.966
300	2.74	2.338	1.015	3.374	0.435	1.564	1.009
360	3.08	2.415	1.052	3.547	0.436	1.546	1.042
420	3.42	2.469	1.076	3.673	0.437	1.535	1.065
480	4.45	2.559	1.106	3.862	0.433	1.527	1.104
540	5.13	2.624	1.122	3.988	0.428	1.528	1.133
600	5.82	2.689	1.125	4.074	0.419	1.541	1.160
720	6.50	2.731	1.119	4.099	0.410	1.557	1.179
840	7.53	2.754	1.114	4.107	0.405	1.568	1.189
960	8.90	2.807	1.097	4.110	0.391	1.598	1.212
1080	10.61	2.831	1.076	4.065	0.381	1.625	1.222
1200	11.98	2.842	1.058	4.016	0.373	1.646	1.227
1320	13.69	2.813	1.027	3.892	0.366	1.669	1.214
1411	15.00	2.787	1.011	3.818	0.364	1.679	1.203

FAILURE SKETCHES





☐ CONTROLLED STRESS

☒ CONTROLLED STRAIN

TEST NO.						
TYPE OF SPECIMEN UNDISTURBED						
INITIAL	WATER CONTENT	w_o	27.9 %	%	%	%
	VOID RATIO	e_o	0.74			
	SATURATION	S_o	98 %	%	%	%
	DRY DENSITY, LB/CU FT	γ_d	93.4			
TIME TO FAILURE, MIN		t_f	32.5			
UNCONFINED COMPRESSIVE STRENGTH, T/SQ FT		q_u	1.28			
UNDRAINED SHEAR STRENGTH, T/SQ FT		s_u	0.64			
SENSITIVITY RATIO		S_t				
INITIAL SPECIMEN DIAMETER, IN		D_o	1.38			
INITIAL SPECIMEN HEIGHT, IN.		H_o	3.01			

CLASSIFICATION Sandy Clay, CL

LL	PL	PI	G_s
42	14	28	2.6

REMARKS Dark gray. Torvane=.45 TSF

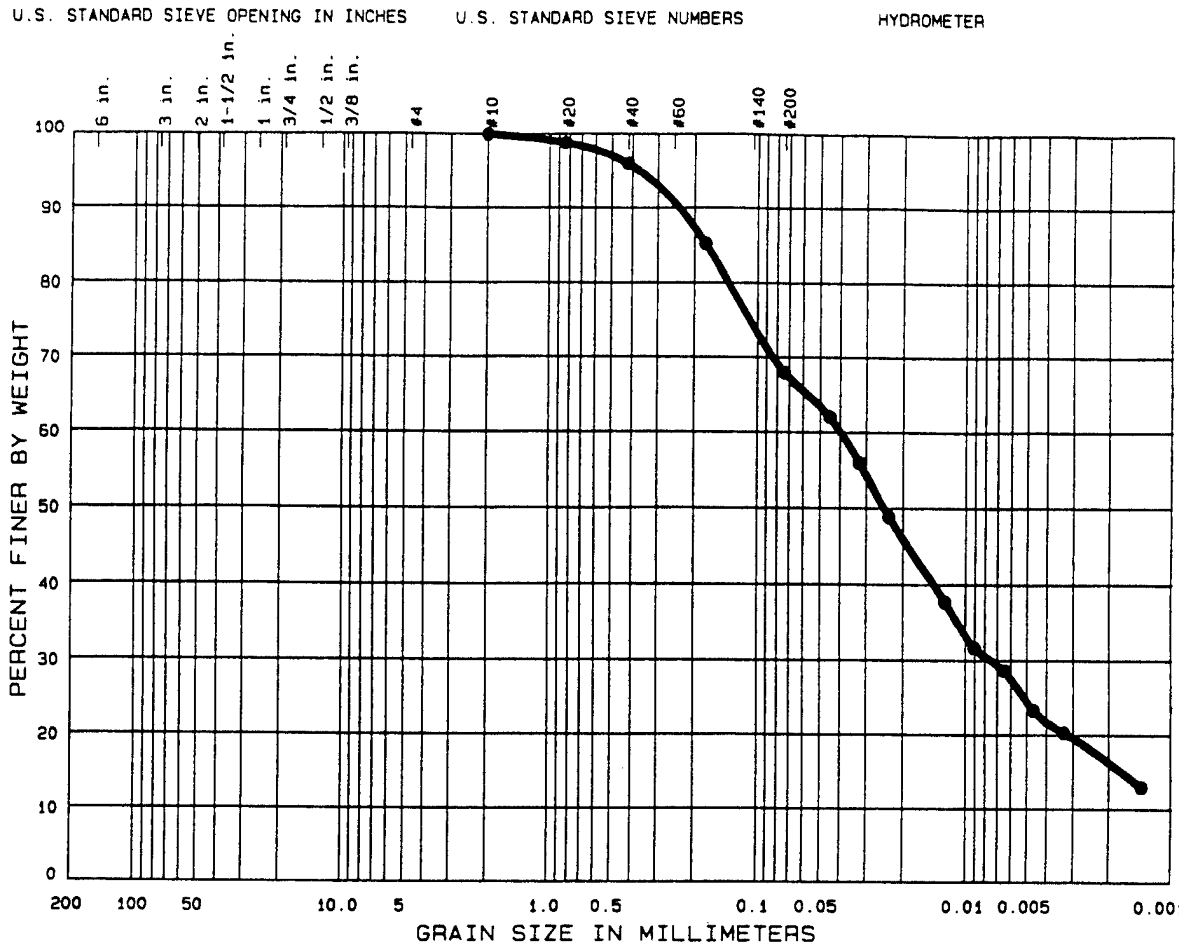
PROJECT	CHASKA; CENCS-IA-92-97-ED-GH
AREA	MRD LAB NO. : 1535
BORING NO. MU 92-171	SAMPLE NO. W-2
DEPTH EL 30'-32'	DATE 7-1-92

UNCONFINED COMPRESSION TEST REPORT

ENG FORM 1 JUN 65 **3659** (EM 1110-2-1906) (TRANSLUCENT) GPO : 1966 OF—214-946 PLATE XI-2

Figure 9 FIG D-257

W.O. No. ch92171
Req. No. CENCS-IA-92-97-ED-GH
Contract No.



% COBBLES	% GRAVEL	% SAND	% SILT OR CLAY	
● 0.0	0.0	32.0	43.6	24.4

	Sample No.	Elev or Depth	Nat W%	LL	PL	PI	C_c	C_u
●	U-2	30.0'-32.0'		42	14	28		

CLASSIFICATION

● SANDY CLAY, CL
SPECIFIC GRAVITY = 2.6

Remarks: Trimmings from consolidation test.	Project CHASKA FLOOD CONTROL Lab No. 1535 Area Boring No. 92-171 MU Date 7/27/92

GRADATION CURVES

CORPS OF ENGINEERS, MISSOURI RIVER DIVISION LAB
420 SOUTH 18th STREET - OMAHA, NE 68102-2586

CLASSIFICATION TEST REQUEST

PROJECT: Cheske

MRD LAB. NO.:

ACCOMPANYING TEST: UNC, R, CON

REQUEST NO.:

CONTAINER - TYPE: Tube

NO.:

SAMPLE IDENTIFICATION: 92-171 MU U-2 30'-32'

SAMPLE IDENTIFICATION:

Structure: ( ) Brittle (✓) Plastic ( )

Consistency: Undisturbed ( ) Soft (✓) Med ( ) Stiff ( ) Hard

Remolded (✓) Insensitive ( ) Sl. Sens. ( ) Sensitive

PL Thread: Strength (✓) Low ( ) Med ( ) High ( )

Shine ( ) None (✓) Dull ( ) Gloss ( ) H. Gloss ( )

Shake Test ( ) None ( ) Slow ( ) Fast ( ) Rapid ( )

Torvane: .45 TSF Bottom .75 TSF top

Odor: none

Color: dark gray

Cementation: not reactive to HCl

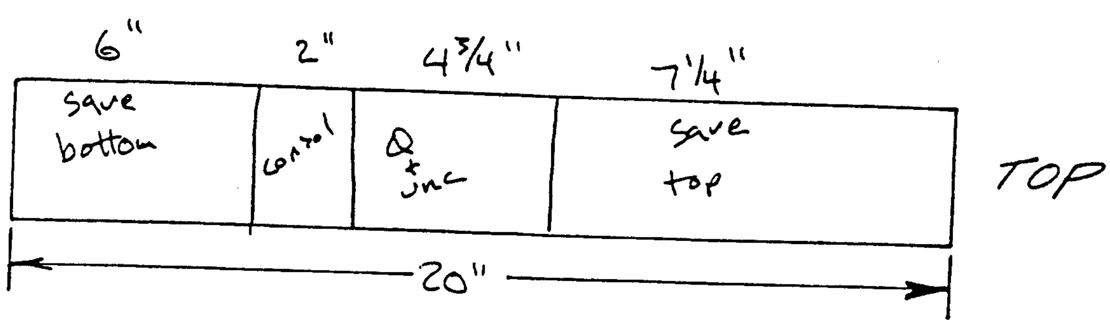
Disturbance: cracks at top 5"

Date Core Opened: 7/1/92

Est. Max. Particle Size:

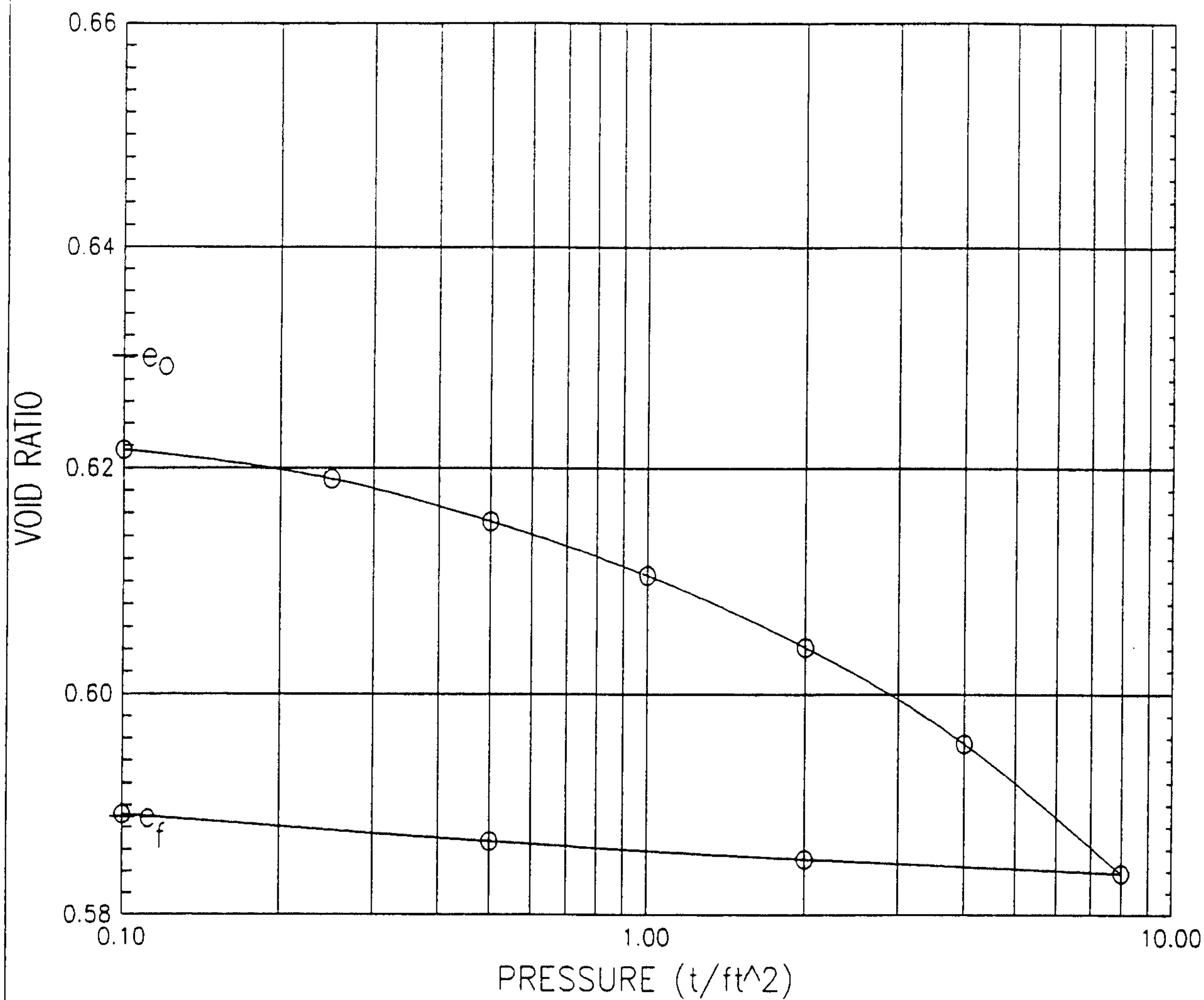
Sketch: (Core description and specimen location)

Remarks: more clayey towards bottom



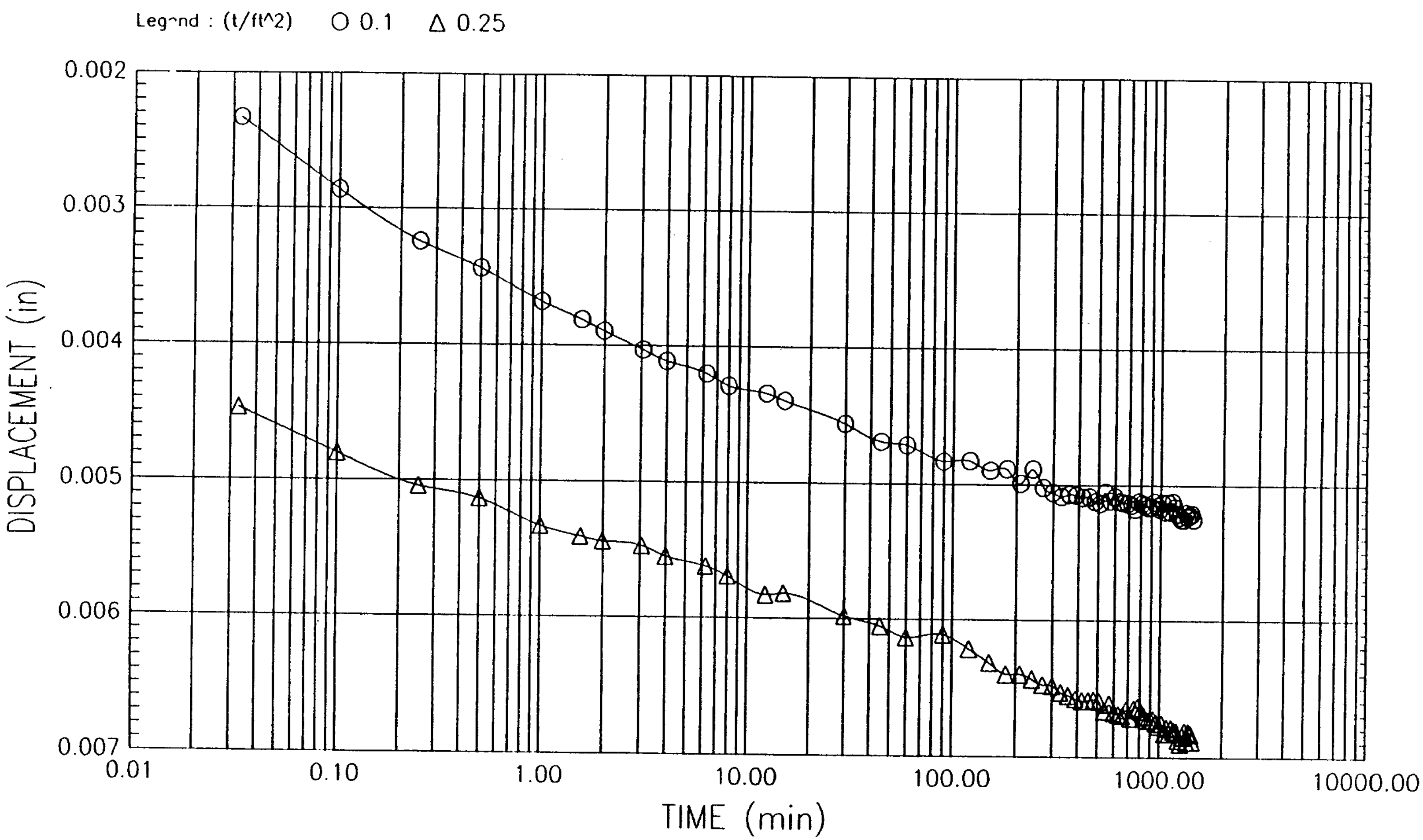
Technician MJW

FIGURE D-259



			BEFORE TEST	AFTER TEST
OVERBURDEN PRESSURE (t/ft^2)		WATER CONTENT (%)	23.566	22.772
PRECONSOL. PRESSURE (t/ft^2)		DRY DENSITY (lb/ft^3)	100.711	103.318
COMPRESSION INDEX		SATURATION (%)	98.338	101.660
TYPE SPECIMEN		VOID RATIO	0.630	0.589
DIA. (in) 2.500	HT. (in) 1.000	BACK PRESSURE (t/ft^2)		
CLASSIFICATION Silty Sand, SM				
LL	PL NP / PI	PROJECT CHASKA FLOOD CONTROL		
GS 2.630	D 10	Data File: LPT1		
REMARKS Light gray-brown. Torvane=		BORING NO. 92-171MU	SAMPLE NO W-3	
.15 TSF. Non-calcareous.		DEPTH 34'-36'	DATE 7/1/92	
		USACE, MRD CONSOLIDATION TEST REPORT		

Figure 11



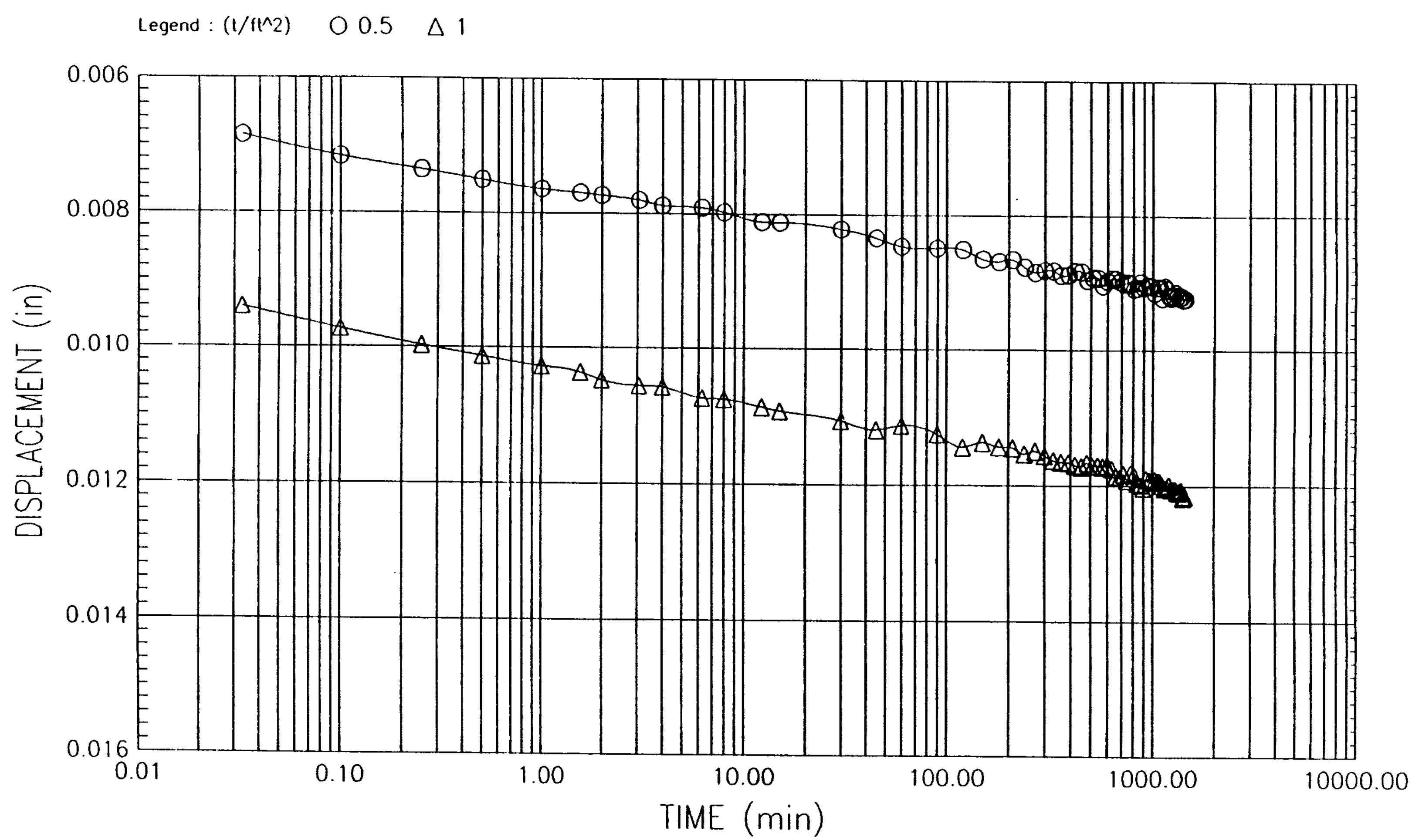
PROJECT	CHASKA FLOOD CONTROL		
	Data File: LPT1		
BORING	92-171MU	SAMPLE NO.	W-3
DEPTH	34'-36'	DATE	7/1/92

USACE, MRD

CONSOLIDATION TEST

TIME CURVES

Figure 12



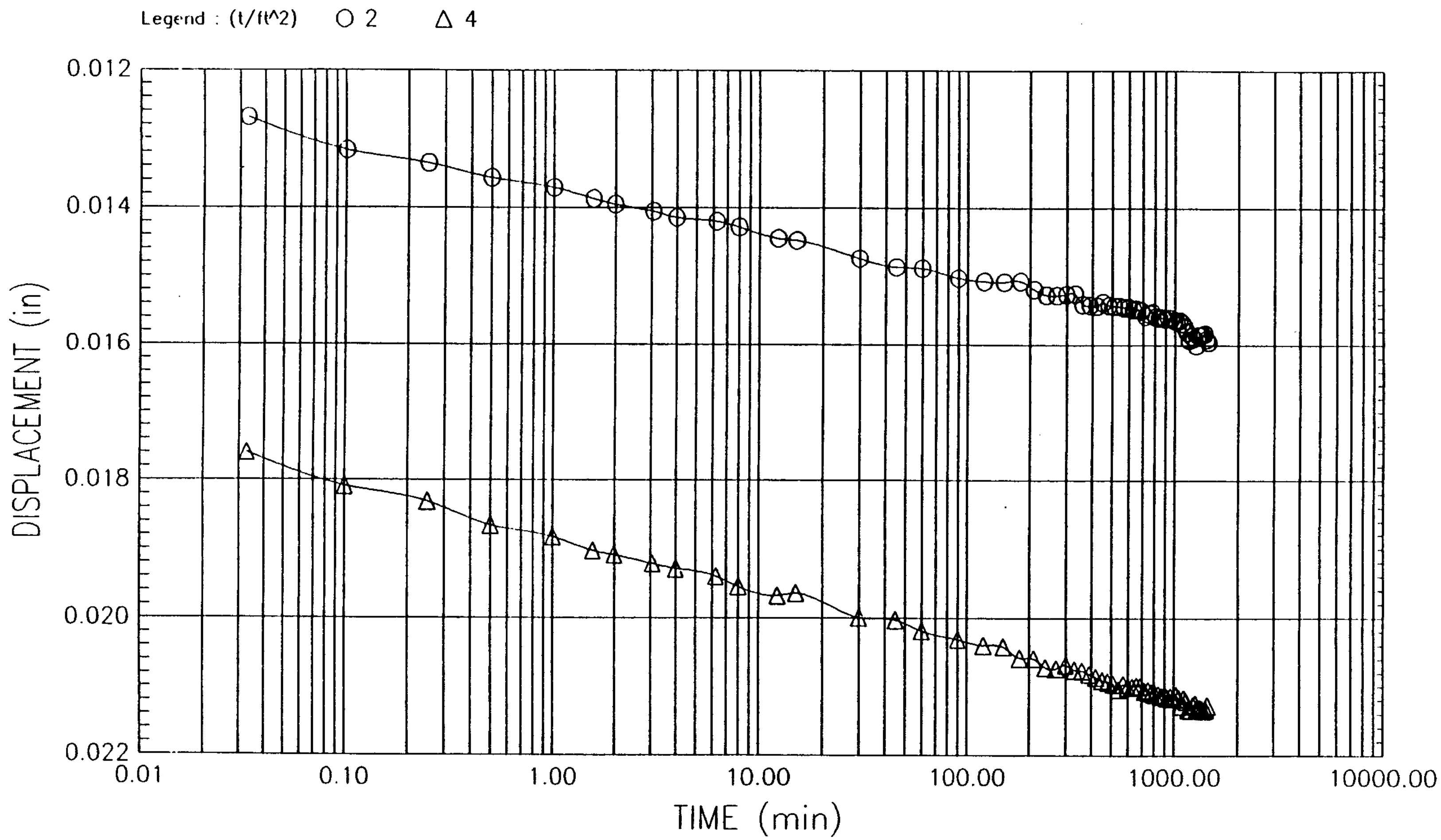
PROJECT	CHASKA FLOOD CONTROL		
	Data File: LPT1		
BORING	92-171MU	SAMPLE NO.	W-3
DEPTH	34'-36'	DATE	7/1/92

USACE, MRD

CONSOLIDATION TEST

TIME CURVES

Figure 13

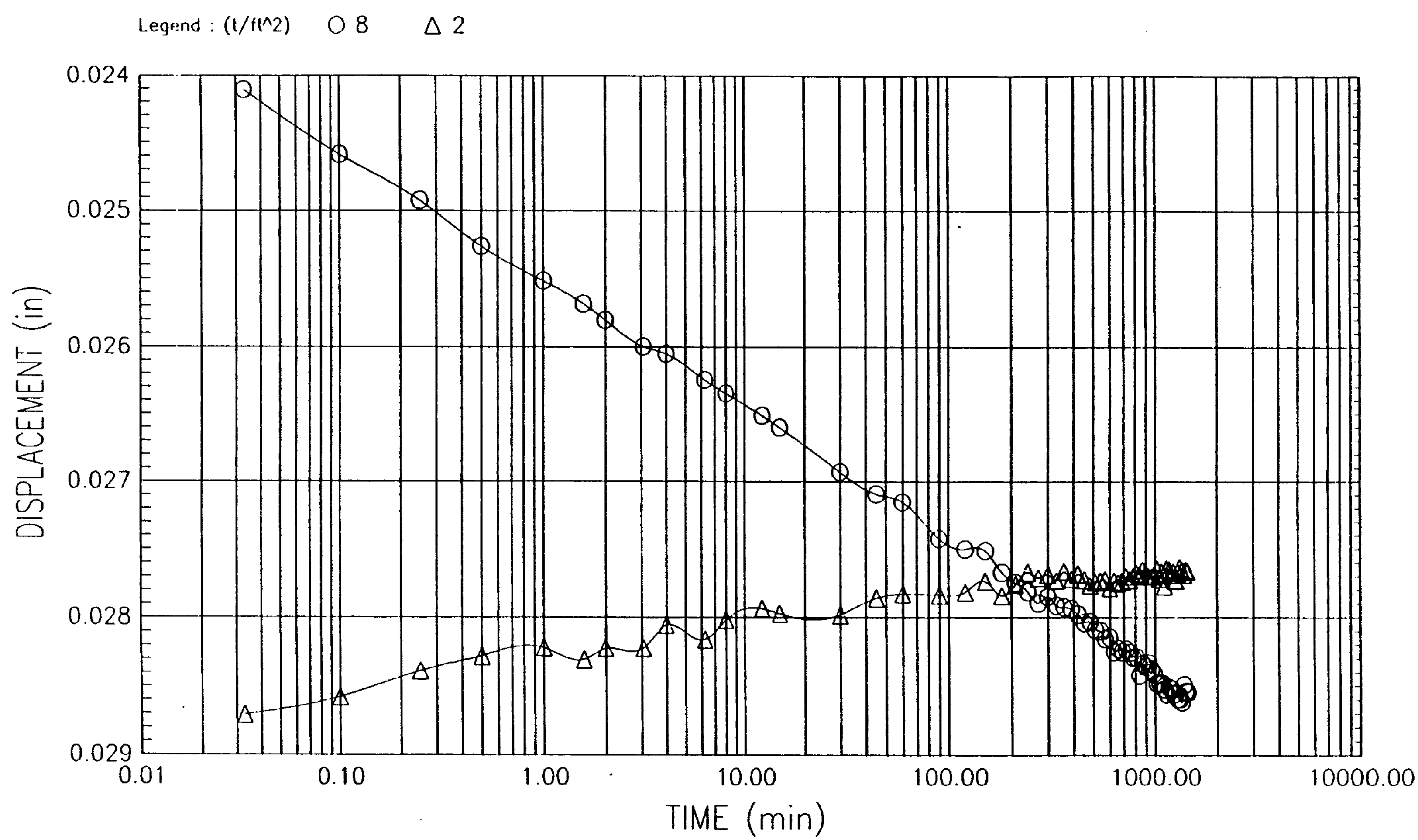


PROJECT	CHASKA FLOOD CONTROL		
	Data File: LPT1		
BORING	92-171MU	SAMPLE NO.	W-3
DEPTH	34'-36'	DATE	7/1/92

USACE, MRD
CONSOLIDATION TEST
TIME CURVES

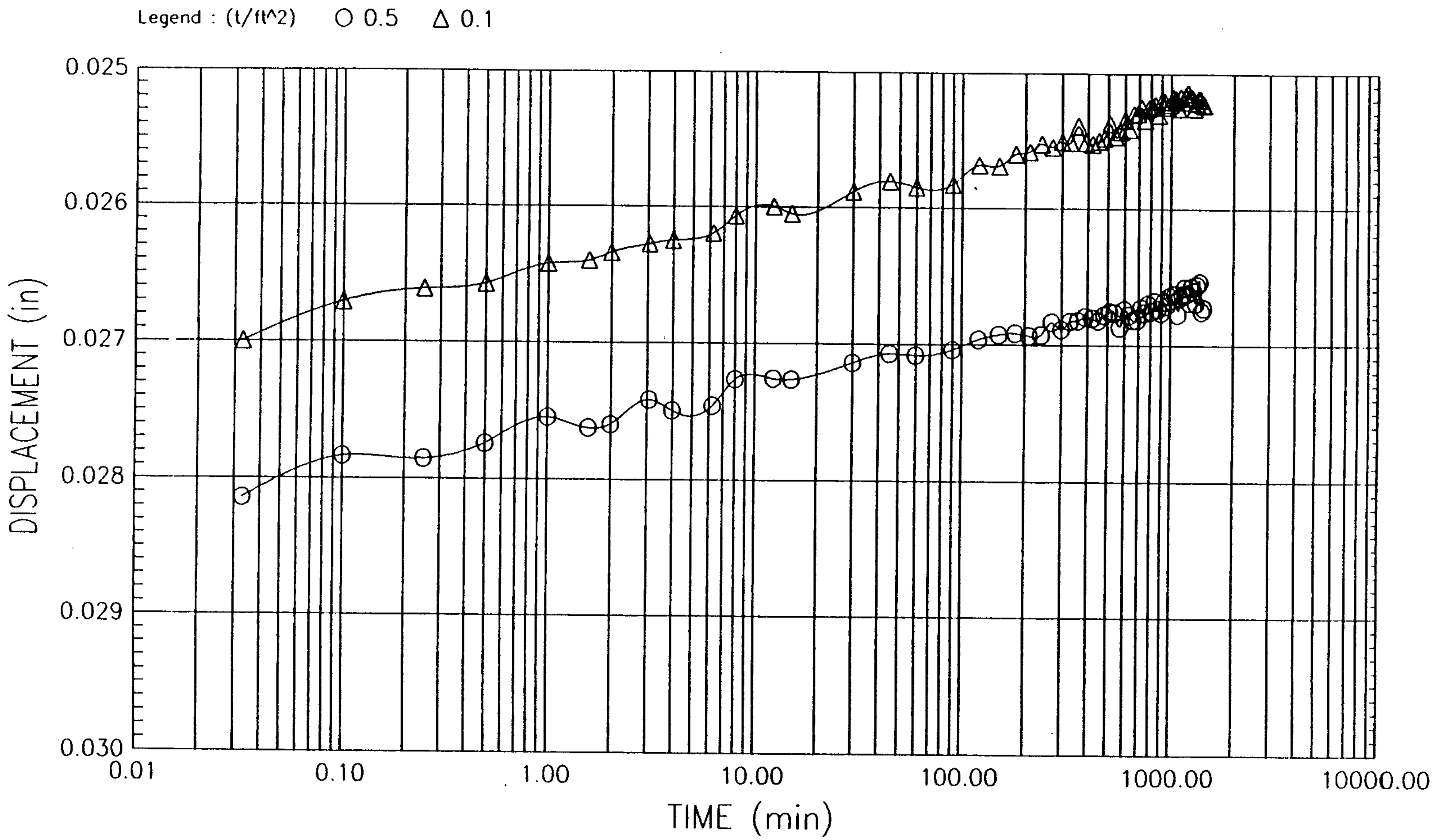
Figure 14

FIGURE D-263



PROJECT	CHASKA FLOOD CONTROL			USACE, MRD CONSOLIDATION TEST TIME CURVES
	Data File: LPT1			
BORING	92-171MU	SAMPLE NO.	W-3	
DEPTH	34'-36'	DATE	7/1/92	

Figure 15



PROJECT	CHASKA FLOOD CONTROL		
	Data File: LPT1		
BORING	92-171MU	SAMPLE NO.	W-3
DEPTH	34'-36'	DATE	7/1/92

USACE, MRD

CONSOLIDATION TEST

TIME CURVES

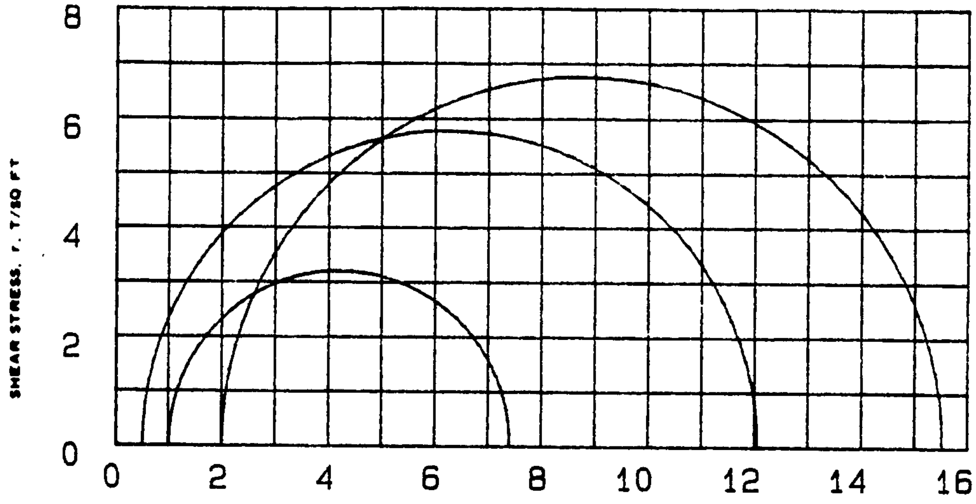
Figure 16

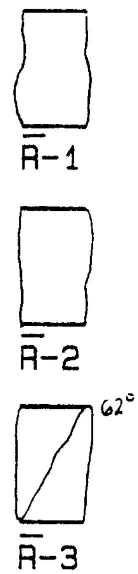
CONSOLIDATION TEST DATA

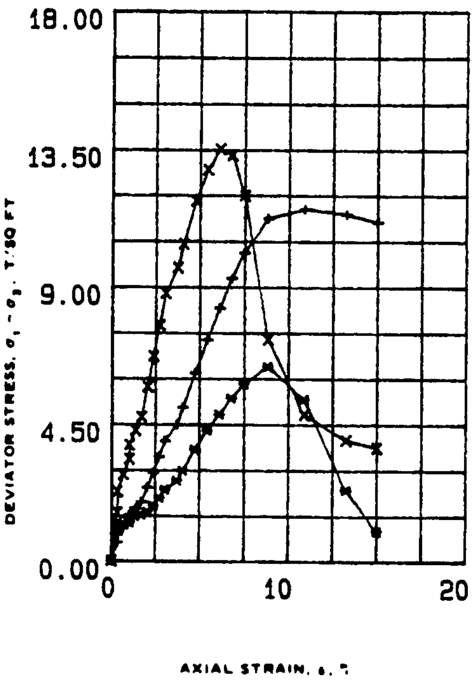
Project : CHASKA FLOOD CONTROL Location : Project No. : 1535
Test No. :
Boring No. : 92-171MU Test Date : 7/1/92 Tested by : MJW
Sample No. : W-3 Sample Type : UNDISTURB Depth : 34'-36'
Checked by :
Soil Description :
Remarks :

	APPLIED PRESSURE (t/ft^2)	FINAL DISPLACEMENT (in)	VOID RATIO	STRAIN AT END (%)	FITTING TIME (min)		COEFFICIENT OF CONSOLIDATION (in^2/s)		
					SQ.RT.	LOG	SQ.RT.	LOG	AVE
1)	0.10	0.005	0.622	0.53	6.3	0.0	1.29E-004	0.00E+000	0.00E+000
2)	0.25	0.007	0.619	0.69	18.7	0.0	4.33E-005	0.00E+000	0.00E+000
3)	0.50	0.009	0.615	0.92	34.9	0.0	2.32E-005	0.00E+000	0.00E+000
4)	1.00	0.012	0.611	1.21	17.4	0.0	4.63E-005	0.00E+000	0.00E+000
5)	2.00	0.016	0.604	1.60	25.7	0.0	3.10E-005	0.00E+000	0.00E+000
6)	4.00	0.021	0.596	2.13	26.2	0.0	3.02E-005	0.00E+000	0.00E+000
7)	8.00	0.029	0.584	2.85	23.4	0.0	3.33E-005	0.00E+000	0.00E+000
8)	2.00	0.028	0.585	2.77	3.7	0.0	2.07E-004	0.00E+000	0.00E+000
9)	0.50	0.027	0.587	2.67	7.7	0.0	1.01E-004	0.00E+000	0.00E+000
10)	0.10	0.025	0.589	2.52	8.4	0.0	9.23E-005	0.00E+000	0.00E+000

-5







SPECIMEN NO.			1 (+)	2 (*)	3 (X)	
INITIAL	WATER CONTENT, %	w_o	20.5	19.1	20	
	DRY DENSITY LB/CU FT	γd_o	104.6	107.7	110.2	
	SATURATION, %	S_o	95	96	100	
	VOID RATIO	e_o	.57	.53	.49	
BEFORE SHEAR	WATER CONTENT, %	w_c	23.4	26.3	22	
	DRY DENSITY LB/CU FT	γd_c	105.4	108.5	111.5	
	SATURATION, %	S_c	100	100	100	
	VOID RATIO	e_c	.56	.51	.47	
	FINAL BACK PRESSURE, T/SQ FT	u_o	4.103	4.103	4.103	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.5	1	2	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	11.547	6.403	13.519	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	1080	960	600	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	11.115	0.993	3.727	
INITIAL DIAMETER, IN.		D_o	1.4	1.4	1.38	
INITIAL HEIGHT, IN.		H_o	2.95	2.95	2.95	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Silty Sand, SM

LL N.V.	PL N.P.	PI	G_s 2.63

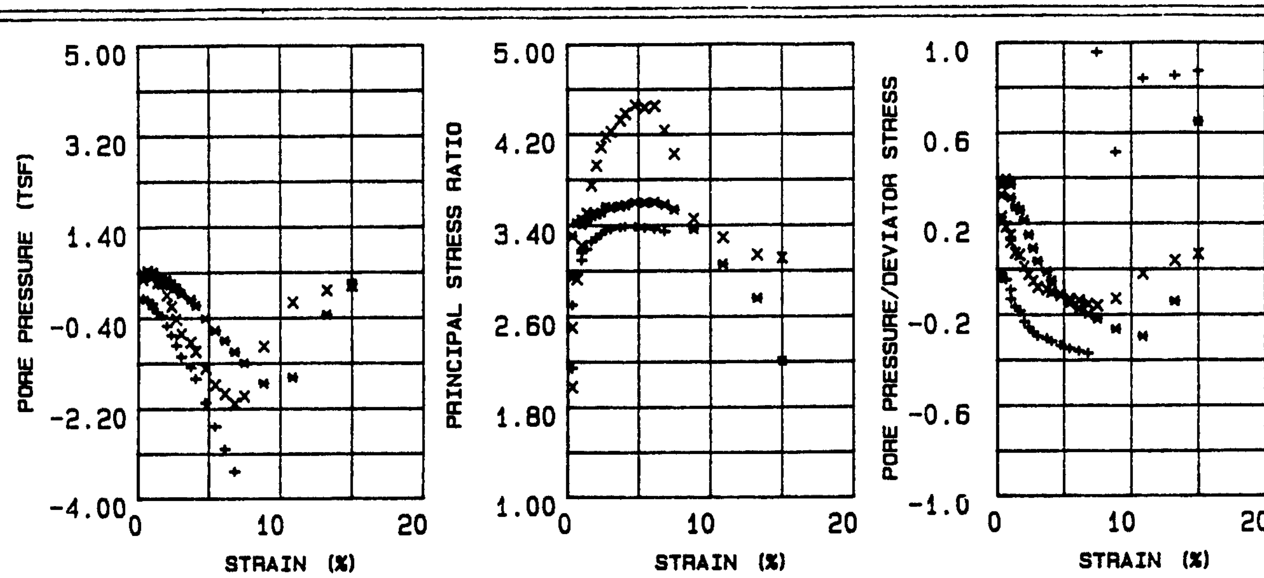
REMARKS: Light gray-brown, non-calcareous. Free surface water on sample. Sample deforms easily. Torvane=0.15 TSF.

TYPE OF SPECIMEN	UNDISTURBED	TYPE OF TEST	RBAR
PROJECT	CHASKA; CENCS-IA-92-97-ED-GH		
BORING NO	92-171 MU	SAMPLE NO.	W-3
DEPTH ELEV	34'-36'		
LABORATORY	1535	DATE	07-29-92

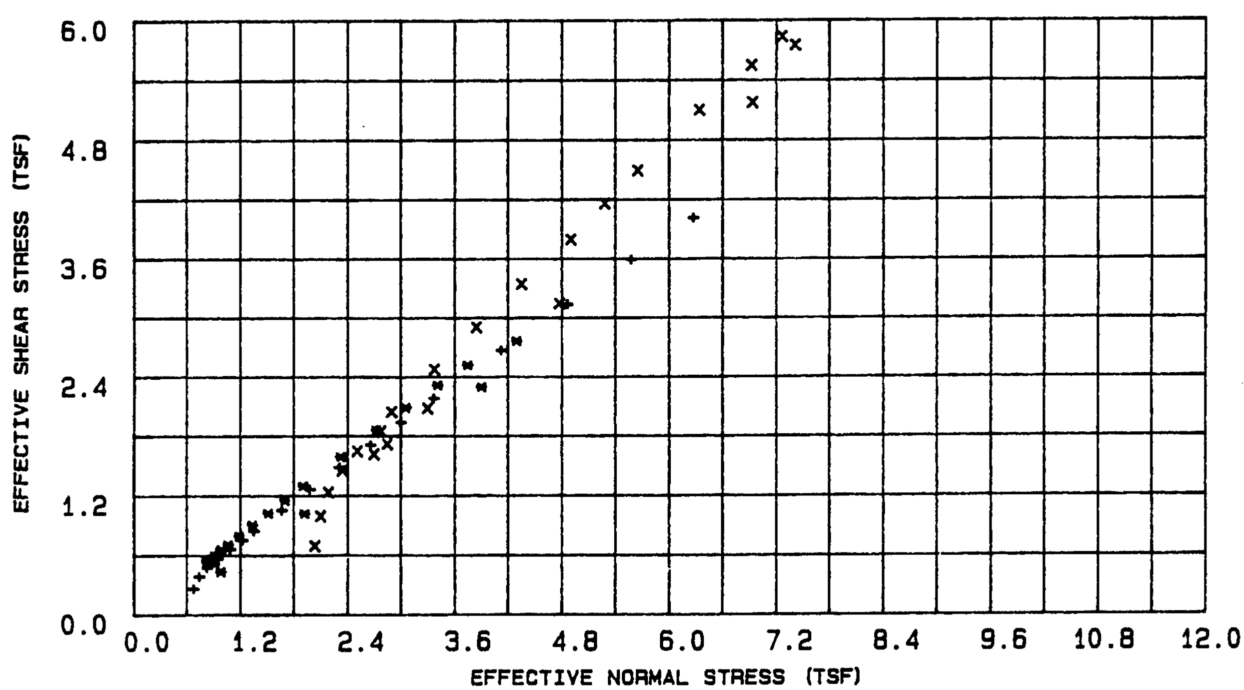
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)
REV JUNE 1970

FIGURE 8



EFFECTIVE STRESS VECTOR CURVES ON 60 DEGREE PLANE



LEGEND	
+ =	.5 TSF
* =	1 TSF
X =	2 TSF

PROJECT	CHASKA: CENCS-IA-92-97-ED-GH
BORING NO.	92-171 MU
SAMPLE NO.	W-3
DEPTH/ELEV	34'-36'
MRD LAB NO.	1535

FIGURE 9

Table 9 - Triaxial $\bar{R}$ Test Results

Project : CHASKA; CENCS-IA-92-97-ED-GH
Boring Number : 92-171 MU
Sample Number : W-3
Depth : 34'-36'
Confining Pressure : .5 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.34	0.601	-0.025	2.144	-0.041	0.674	0.259
30	0.34	0.883	-0.020	2.697	-0.022	0.739	0.381
45	0.68	1.089	-0.053	2.969	-0.048	0.823	0.470
60	1.02	1.300	-0.122	3.091	-0.093	0.944	0.561
90	1.02	1.521	-0.205	3.157	-0.134	1.082	0.657
120	1.36	1.734	-0.293	3.187	-0.168	1.222	0.749
150	1.70	1.951	-0.366	3.254	-0.187	1.349	0.842
180	2.04	2.429	-0.564	3.284	-0.232	1.665	1.048
210	2.38	2.916	-0.756	3.322	-0.259	1.978	1.259
240	2.72	3.433	-0.958	3.354	-0.279	2.308	1.482
300	3.06	3.963	-1.178	3.362	-0.297	2.659	1.710
360	3.74	4.484	-1.385	3.378	-0.308	2.995	1.935
420	4.07	5.049	-1.616	3.386	-0.320	3.366	2.179
480	4.75	6.178	-2.091	3.385	-0.338	4.121	2.666
[illegible]40	5.43	7.272	-2.565	3.373	-0.352	4.865	3.139
600	6.11	8.311	-3.019	3.362	-0.363	5.577	3.587
720	6.79	9.291	-3.472	3.339	-0.373	6.272	4.010
840	7.47	10.115	9.688	-0.101	0.958	-6.684	4.365
960	8.83	11.242	5.734	-1.148	0.511	-2.451	4.852
1080	10.87	11.547	9.688	-0.257	0.839	-6.329	4.984
1200	13.24	11.371	9.688	-0.238	0.852	-6.373	4.908
1288	15.00	11.115	9.688	-0.210	0.872	-6.436	4.797

Table 10 - Triaxial $\overline{R}$ Test Results

Project : CHASKA; CENCS-IA-92-97-ED-GH
Boring Number : 92-171 MU
Sample Number : W-3
Depth : 34'-36'
Confining Pressure : 1 TSF

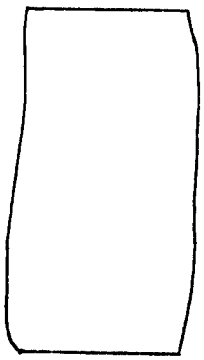
Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.34	1.195	0.386	2.947	0.323	0.910	0.516
30	0.34	1.247	0.459	3.304	0.368	0.850	0.538
45	0.68	1.235	0.489	3.417	0.396	0.817	0.533
60	1.02	1.275	0.469	3.402	0.369	0.847	0.550
90	1.02	1.382	0.428	3.418	0.310	0.914	0.597
120	1.36	1.472	0.395	3.434	0.269	0.969	0.635
150	1.70	1.524	0.387	3.485	0.254	0.990	0.658
180	2.04	1.636	0.344	3.495	0.211	1.061	0.706
210	2.38	1.835	0.269	3.511	0.147	1.185	0.792
240	2.72	2.092	0.184	3.562	0.088	1.334	0.903
300	3.05	2.365	0.074	3.554	0.032	1.512	1.021
360	3.73	2.665	-0.039	3.565	-0.014	1.699	1.150
420	4.07	2.997	-0.162	3.579	-0.054	1.904	1.293
480	4.75	3.679	-0.415	3.600	-0.112	2.326	1.588
540	5.43	4.303	-0.658	3.595	-0.152	2.723	1.857
600	6.11	4.833	-0.860	3.599	-0.177	3.057	2.086
720	6.79	5.364	-1.084	3.574	-0.202	3.412	2.315
840	7.47	5.830	-1.305	3.530	-0.223	3.748	2.516
960	8.83	6.403	-1.711	3.361	-0.267	4.296	2.764
1080	10.86	5.311	-1.587	3.053	-0.298	3.902	2.292
1200	13.24	2.346	-0.338	2.753	-0.143	1.919	1.012
1288	15.00	0.993	0.270	2.200	0.648	0.976	0.429

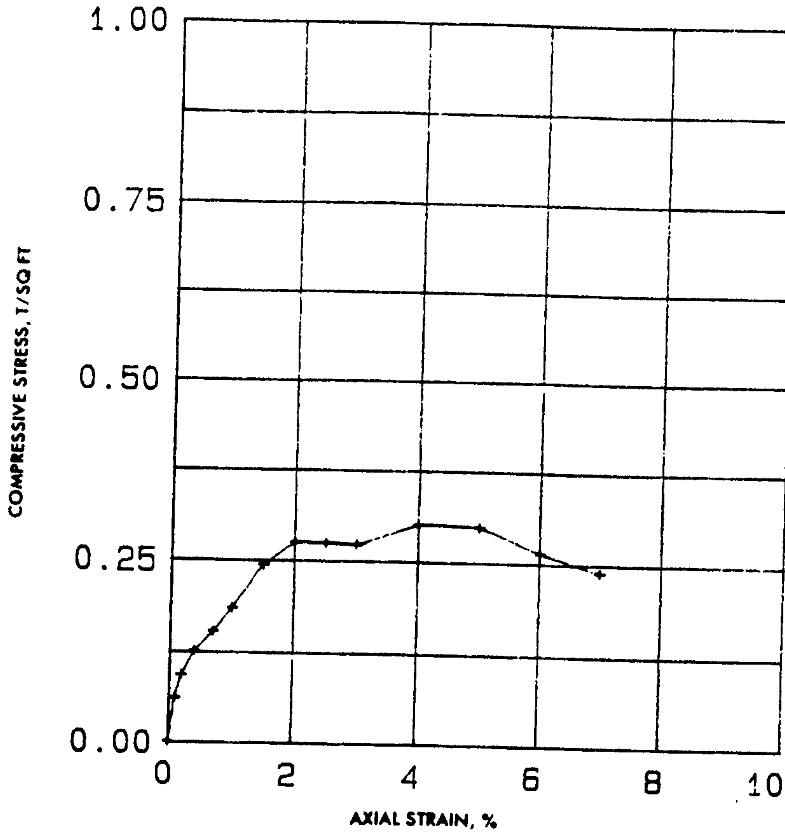
Table 11 - Triaxial $\bar{R}$ Test Results

Project : CHASKA; CENCS-IA-92-97-ED-GH
Boring Number : 92-171 MU
Sample Number : W-3
Depth : 34'-36'
Confining Pressure : 2 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.34	1.600	0.361	1.976	0.226	2.035	0.691
30	0.34	2.296	0.469	2.500	0.205	2.099	0.991
45	0.68	2.850	0.521	2.926	0.183	2.185	1.230
60	1.02	3.352	0.486	3.214	0.145	2.344	1.447
90	1.02	3.815	0.436	3.440	0.115	2.508	1.646
120	1.36	4.283	0.287	3.501	0.068	2.773	1.849
150	1.70	4.734	0.277	3.748	0.059	2.895	2.043
180	2.04	5.725	0.042	3.923	0.008	3.375	2.471
210	2.38	6.727	-0.181	4.085	-0.026	3.846	2.903
240	2.72	7.741	-0.433	4.181	-0.055	4.350	3.341
300	3.06	8.785	-0.726	4.223	-0.082	4.901	3.792
360	3.74	9.631	-0.898	4.323	-0.093	5.282	4.157
420	4.08	10.403	-1.076	4.382	-0.103	5.651	4.490
480	4.76	11.809	-1.415	4.458	-0.119	6.339	5.097
540	5.44	12.844	-1.740	4.435	-0.135	6.920	5.544
600	6.12	13.519	-1.918	4.450	-0.141	7.265	5.835
720	6.80	13.316	-2.117	4.234	-0.158	7.414	5.747
840	7.48	11.977	-1.966	4.020	-0.164	6.931	5.169
960	8.84	7.273	-0.971	3.448	-0.133	4.772	3.139
1080	10.88	4.811	-0.104	3.286	-0.021	3.295	2.076
1200	13.26	3.970	0.138	3.132	0.035	2.845	1.713
1287	15.00	3.727	0.230	3.105	0.063	2.693	1.609

FAILURE SKETCHES





☐ CONTROLLED STRESS

☒ CONTROLLED STRAIN

TEST NO.						
TYPE OF SPECIMEN UNDISTURBED						
INITIAL	WATER CONTENT	w_o	30.8 %	%	%	%
INITIAL	VOID RATIO	e_o	0.88			
INITIAL	SATURATION	S_o	92 %	%	%	%
INITIAL	DRY DENSITY, LB/CU FT	γ_d	87.3			
TIME TO FAILURE, MIN		t_f	7.0			
UNCONFINED COMPRESSIVE STRENGTH, T/SQ FT		q_u	0.30			
UNDRAINED SHEAR STRENGTH, T/SQ FT		s_u				
SENSITIVITY RATIO		S_t				
INITIAL SPECIMEN DIAMETER, IN		D_o	1.40			
INITIAL SPECIMEN HEIGHT, IN.		H_o	3.00			

CLASSIFICATION Silty Sand, SM

LL	PL N.P.	PI	G_s 2.63

REMARKS Light gray-brown. Torvane= .15 TSF. Non-calcareous. Sample too soft to get accurate dimensions.

PROJECT	CHASKA; CENCS-IA-92-97-ED-GH		
AREA	MRD LAB NO. : 1535		
BORING NO.	MU 92-171	SAMPLE NO.	W-3
DEPTH EL	34'-36'	DATE	7-1-92

UNCONFINED COMPRESSION TEST REPORT

ENG FORM 3659 (EM 1110-2-1906)
1 JUN 65

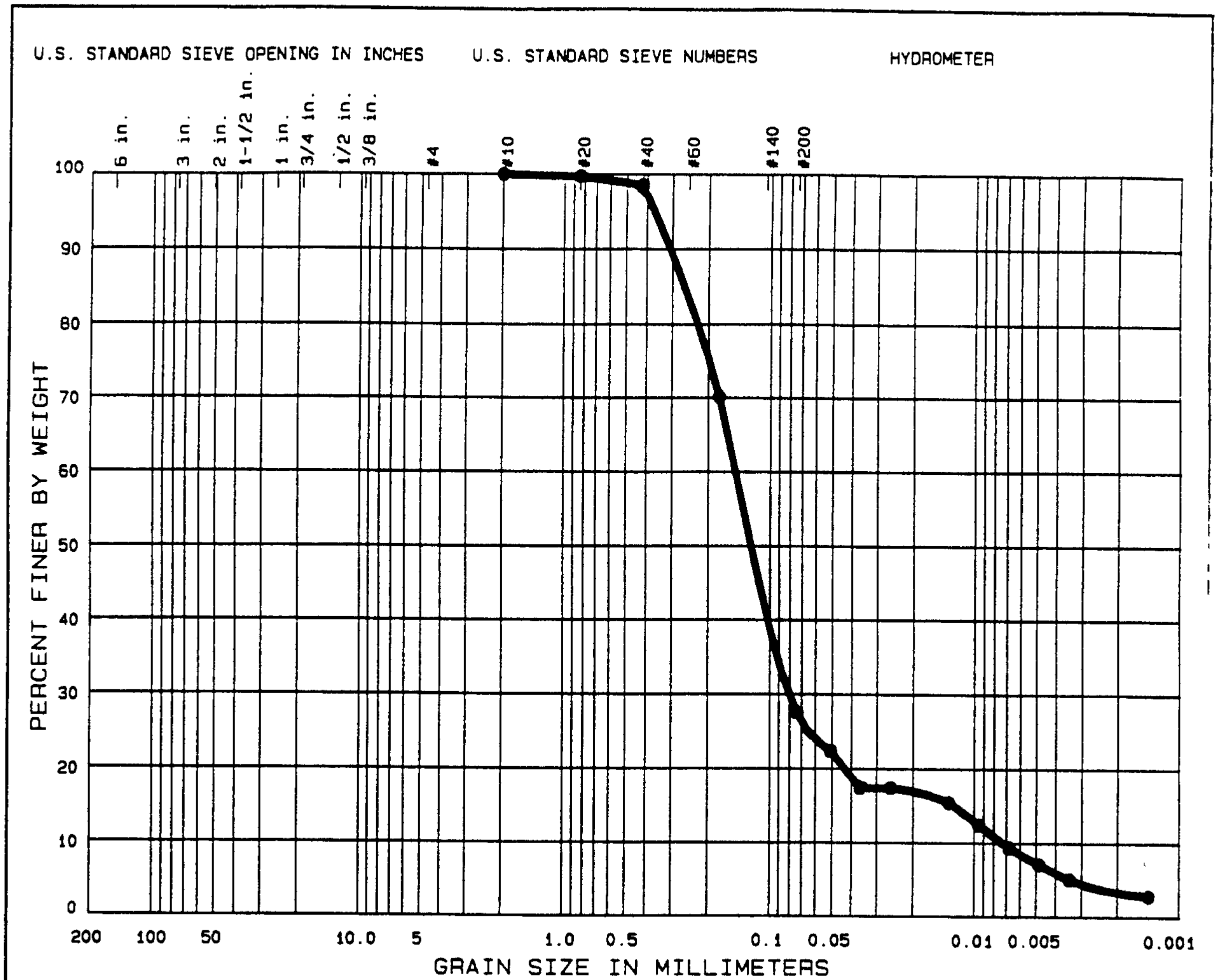
(TRANSLUCENT)

GPO : 1966 OF—214-946

PLATE XI-2

Figure 17 FIG D-272

W.O. No. 1535
Req. No.
Contract No. NA



	% COBBLES	% GRAVEL	% SAND	% SILT OR CLAY	
●	0.0	0.0	72.4	20.3	7.3

	Sample No.	Elev or Depth	Nat W%	LL	PL	PI	C_c	C_u
●	U-3	34'- 36'		N.V.	N.P.		6.07	20.3

CLASSIFICATION

● SILTY SAND SM

Remarks: Trimmings from consolidation specimen.

Project CHASKA FLOOD CONTROL

Lab No. 1535

Area

Boring No. 92-171MU Date 7-16-92

GRADATION CURVES

CORPS OF ENGINEERS, MISSOURI RIVER DIVISION LAB
420 SOUTH 18th STREET - OMAHA, NE 68102-2586

Figure 18 FIG D-273

CLASSIFICATION TEST REQUEST

PROJECT: Cheska

MRD LAB. NO.:

ACCOMPANYING TEST: UNC, R, CON.

REQUEST NO.:

CONTAINER - TYPE: TUBE

NO.:

SAMPLE IDENTIFICATION: 92-171 MU U-3 34'-36'

SAMPLE IDENTIFICATION:

Structure: ( ) Brittle ( ) Plastic ( )

Consistency: Undisturbed (✓) Soft ( ) Med ( ) Stiff ( ) Hard

Remolded ( ) Insensitive ( ) Sl. Sens. ( ) Sensitive

PL Thread: Strength (✓) Low ( ) Med ( ) High ( )

Shine (✓) None ( ) Dull ( ) Gloss ( ) H. Gloss ( )

Shake Test ( ) None ( ) Slow ( ) Fast ( ) Rapid ( )

Torvane: .15 TSF

Odor: none

Color: light grey-brown

Cementation: no reaction to HCl

Disturbance: none

Date Core Opened: July 7.

Est. Max. Particle Size:

Sketch: (Core description and specimen location)

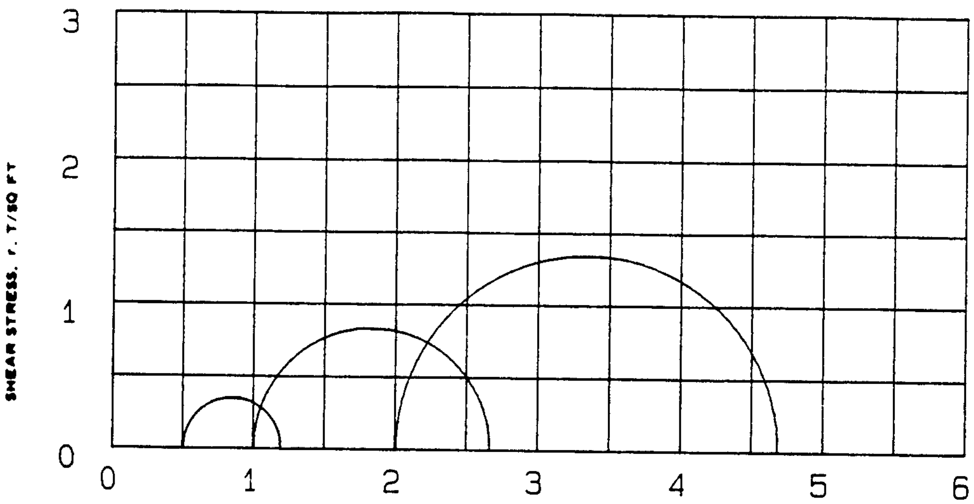
Remarks: Lots of free standing water on surface of sample

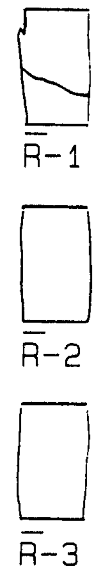
Sample very soft + saturated. Sandy with some clay pockets at top and bottom of sample

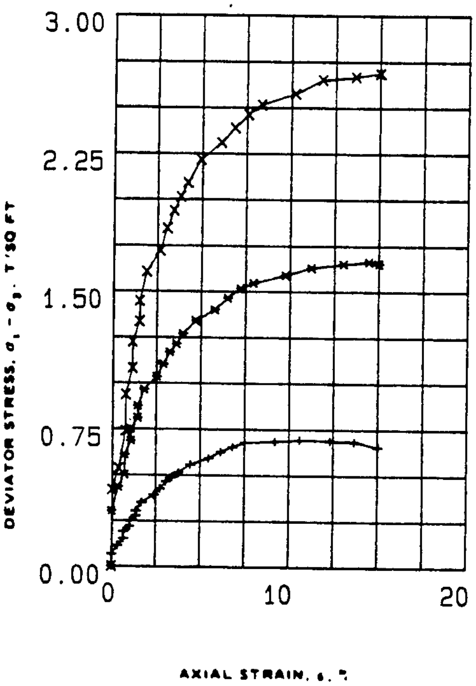
6"	2"	4½"	5"	5½"	
Saved	CON	UNC	R	discard	TOP

← 23" →

Technician PK







SPECIMEN NO.			1 (+)	2 (*)	3 (X)	
INITIAL	WATER CONTENT, %	w_o	185.9	195.9	190.8	
	DRY DENSITY LB/CU FT	γ_{d_o}	25.9	23	23.9	
	SATURATION, %	S_o	99	90	92	
	VOID RATIO	e_o	3.48	4.04	3.86	
BEFORE SHEAR	WATER CONTENT, %	w_c	173.9	187.1	160.6	
	DRY DENSITY LB/CU FT	γ_{d_c}	27.9	29.7	35.8	
	SATURATION, %	S_c	100	100	100	
	VOID RATIO	e_c	3.17	2.91	2.24	
	FINAL BACK PRESSURE, T/SQ FT	u_o	4.103	4.823	4.103	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.5	1	2	
MAXIMUM DEVIATOR STRESS, T/SQ FT	$(\sigma_1 - \sigma_3)_{max}$		0.693	1.664	2.686	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	1200	1440	1428	
ULTIMATE DEVIATOR STRESS, T/SQ FT	$(\sigma_1 - \sigma_3)_{ult}$		0.654	1.653	2.686	
INITIAL DIAMETER, IN.		D_o	1.4	1.4	1.39	
INITIAL HEIGHT, IN.		H_o	2.99	3	3	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Organic Silt, OH

LL 347	PL 201	PI 146	Gs 1.86	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST RBAR

REMARKS: Black, highly calcareous, organic odor. Torvane=0.45 TSF.

PROJECT CHASKA; CENCS-IA-92-97-ED-GH

BORING NO 92-172 MU — SAMPLE NO. W-1

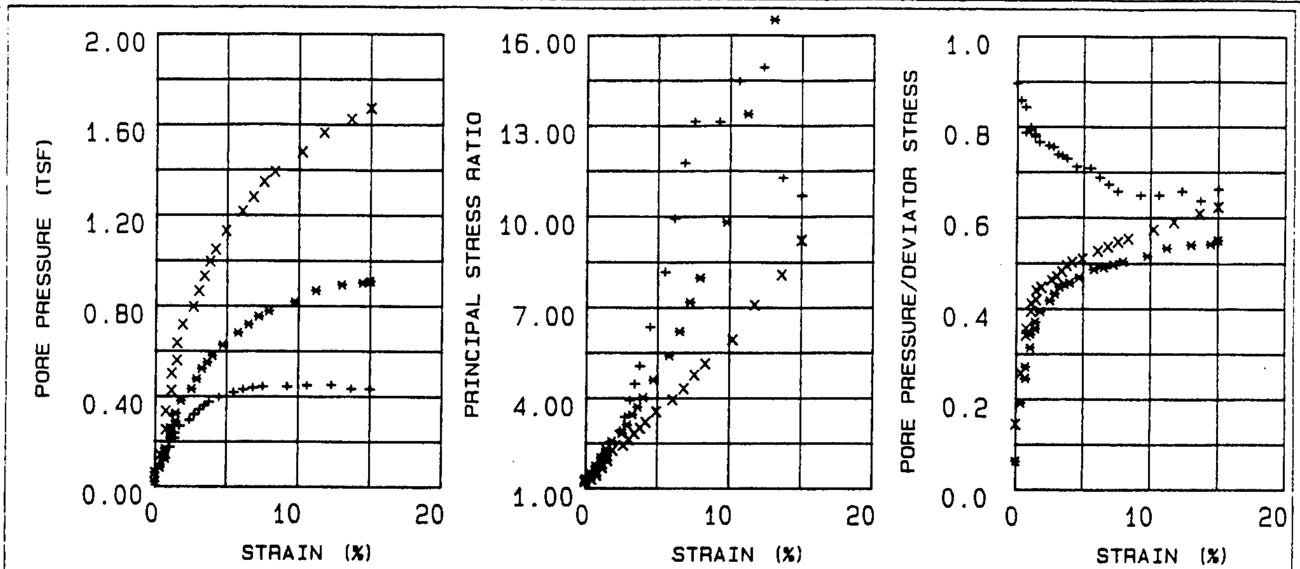
DEPTH ELEV 29'-31'

LABORATORY 1535 — DATE 08-04-92

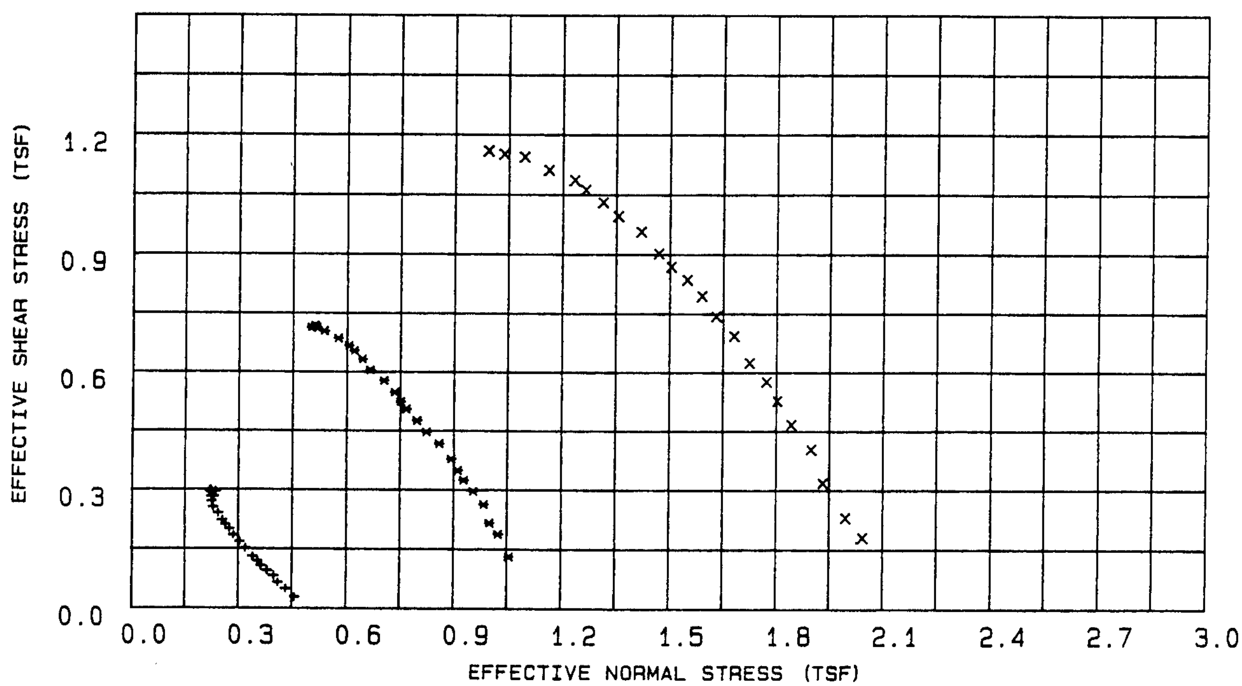
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 — PREVIOUS EDITION IS OBSOLETE — TRANSLUCENT — (EM 1110-2-1906)

FIGURE 10



EFFECTIVE STRESS VECTOR CURVES ON 60 DEGREE PLANE



LEGEND

+ = .5 TSF

✱ = 1 TSF

X = 2 TSF

PROJECT	CHASKA; CENCS-IA-92-97-ED-GH
BORING NO.	92-172 MU
SAMPLE NO.	W-1
DEPTH/ELEV	29'-31'
MRD LAB NO.	1535

FIGURE 11

R

Table 12 - Triaxial $\bar{R}$ Test Results

Project : CHASKA; CENCS-IA-92-97-ED-GH
Boring Number : 92-172 MU
Sample Number : W-1
Depth : 29'-31'
Confining Pressure : .5 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.00	0.066	0.059	1.150	0.896	0.457	0.028
30	0.34	0.113	0.096	1.279	0.858	0.432	0.049
45	0.68	0.150	0.127	1.403	0.843	0.410	0.065
60	0.68	0.190	0.149	1.540	0.786	0.398	0.082
90	1.03	0.220	0.174	1.675	0.793	0.380	0.095
120	1.03	0.248	0.198	1.821	0.799	0.363	0.107
150	1.37	0.276	0.215	1.967	0.778	0.353	0.119
180	1.37	0.302	0.236	2.146	0.782	0.339	0.130
210	1.71	0.350	0.268	2.509	0.765	0.319	0.151
240	2.40	0.390	0.295	2.906	0.757	0.302	0.168
300	2.74	0.425	0.320	3.369	0.754	0.285	0.184
360	3.08	0.464	0.341	3.921	0.737	0.274	0.200
420	3.42	0.489	0.359	4.475	0.735	0.262	0.211
480	3.76	0.514	0.374	5.067	0.728	0.253	0.222
540	4.45	0.557	0.396	6.357	0.711	0.242	0.240
600	5.48	0.591	0.418	8.176	0.707	0.228	0.255
720	6.16	0.626	0.430	9.929	0.687	0.225	0.270
840	6.84	0.654	0.439	11.758	0.672	0.223	0.282
960	7.53	0.677	0.444	13.144	0.657	0.224	0.292
1080	9.24	0.685	0.444	13.121	0.648	0.225	0.295
1200	10.61	0.693	0.449	14.464	0.648	0.222	0.299
1320	12.32	0.687	0.451	14.931	0.657	0.219	0.296
1440	13.69	0.683	0.433	11.255	0.636	0.236	0.295
1531	15.00	0.654	0.432	10.671	0.662	0.230	0.282
1531	15.00	0.654	0.432	10.671	0.662	0.230	0.282

Table 13 - Triaxial $\bar{R}$ Test Results

Project : CHASKA; CENCS-IA-92-97-ED-GH
Boring Number : 92-172 MU
Sample Number : W-1
Depth : 29'-31'
Confining Pressure : 1 TSF

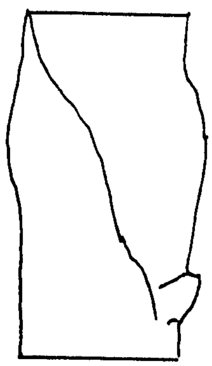
Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.00	0.303	0.019	1.309	0.062	1.056	0.131
30	0.36	0.435	0.083	1.475	0.191	1.025	0.188
45	0.72	0.501	0.123	1.571	0.246	1.001	0.216
60	0.72	0.610	0.166	1.732	0.272	0.985	0.263
90	1.08	0.686	0.215	1.874	0.314	0.955	0.296
120	1.08	0.751	0.258	2.013	0.344	0.928	0.324
150	1.45	0.810	0.288	2.137	0.356	0.912	0.349
180	1.45	0.875	0.324	2.294	0.371	0.893	0.378
210	1.81	0.965	0.380	2.557	0.394	0.859	0.417
240	2.53	1.036	0.433	2.826	0.418	0.823	0.447
300	2.89	1.103	0.477	3.107	0.433	0.796	0.476
360	3.25	1.169	0.523	3.450	0.448	0.766	0.505
420	3.62	1.214	0.551	3.702	0.454	0.750	0.524
480	3.98	1.269	0.580	4.018	0.457	0.734	0.548
540	4.70	1.340	0.628	4.601	0.469	0.704	0.578
600	5.78	1.401	0.682	5.403	0.487	0.665	0.605
720	6.51	1.464	0.719	6.202	0.491	0.643	0.632
840	7.23	1.516	0.755	7.177	0.498	0.620	0.654
960	7.95	1.546	0.778	7.976	0.504	0.605	0.667
1080	9.76	1.590	0.819	9.800	0.516	0.575	0.686
1200	11.21	1.630	0.868	13.381	0.533	0.536	0.704
1320	13.02	1.652	0.894	16.519	0.541	0.515	0.713
1440	14.46	1.664	0.902	18.012	0.543	0.510	0.718
1475	15.00	1.653	0.909	19.359	0.551	0.501	0.713
1475	15.00	1.653	0.909	19.359	0.551	0.501	0.713

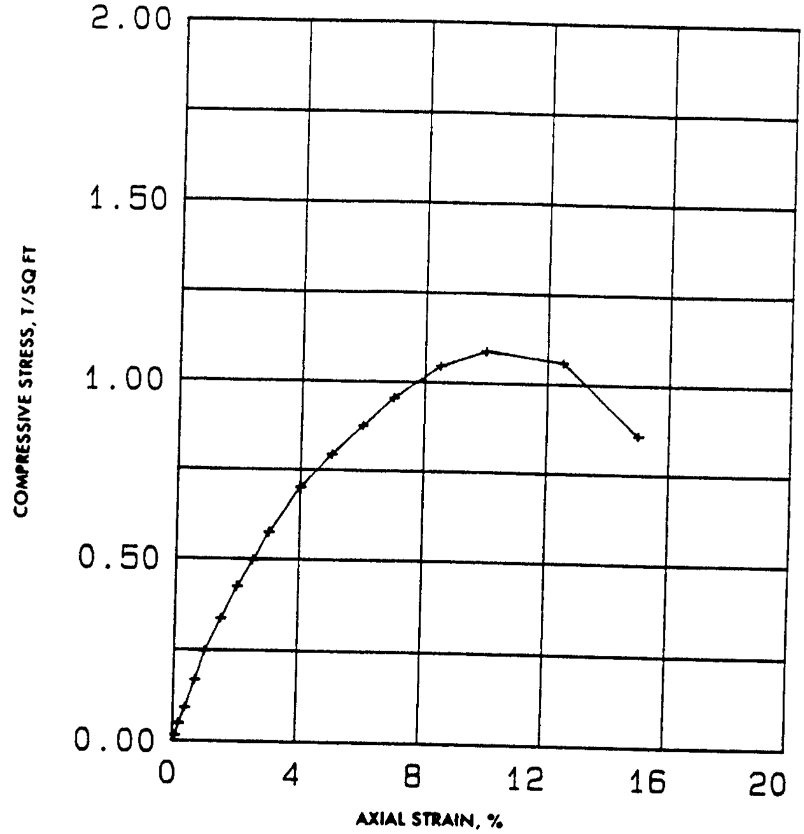
Table 14 - Triaxial $\bar{R}$ Test Results

Project : CHASKA; CENCS-IA-92-97-ED-GH
Boring Number : 92-172 MU
Sample Number : W-1
Depth : 29'-31'
Confining Pressure : 2 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.00	0.417	0.060	1.215	0.144	2.043	0.180
30	0.38	0.534	0.137	1.287	0.257	1.995	0.230
45	0.76	0.737	0.251	1.421	0.341	1.931	0.318
60	0.76	0.935	0.333	1.561	0.356	1.898	0.403
90	1.14	1.080	0.425	1.685	0.394	1.842	0.466
120	1.14	1.222	0.501	1.815	0.411	1.801	0.527
150	1.51	1.334	0.559	1.926	0.419	1.771	0.576
180	1.51	1.445	0.635	2.058	0.440	1.723	0.624
210	1.89	1.605	0.717	2.251	0.447	1.680	0.693
240	2.65	1.721	0.796	2.429	0.463	1.630	0.743
300	3.03	1.842	0.866	2.624	0.471	1.590	0.795
360	3.41	1.937	0.932	2.815	0.482	1.548	0.836
420	3.79	2.014	0.996	3.005	0.495	1.503	0.869
480	4.17	2.090	1.049	3.198	0.502	1.468	0.902
540	4.92	2.216	1.130	3.547	0.510	1.419	0.957
600	6.06	2.308	1.216	3.944	0.527	1.355	0.996
720	6.82	2.388	1.279	4.311	0.536	1.312	1.031
840	7.57	2.461	1.346	4.761	0.547	1.263	1.062
960	8.33	2.515	1.391	5.131	0.554	1.232	1.086
1080	10.22	2.575	1.477	5.927	0.574	1.160	1.111
1200	11.74	2.651	1.564	7.079	0.590	1.092	1.144
1320	13.63	2.668	1.624	8.088	0.609	1.036	1.151
1428	15.00	2.686	1.672	9.216	0.623	0.992	1.159
1428	15.00	2.686	1.672	9.216	0.623	0.992	1.159
1428	15.00	2.686	1.672	9.216	0.623	0.992	1.159

FAILURE SKETCHES





☐ CONTROLLED STRESS

☒ CONTROLLED STRAIN

TEST NO.					
TYPE OF SPECIMEN UNDISTURBED					
INITIAL WATER CONTENT	w_o	194.5 %	%	%	%
INITIAL VOID RATIO	e_o	3.80			
INITIAL SATURATION	S_o	95 %	%	%	%
INITIAL DRY DENSITY, LB/CU FT	γ_d	24.2			
TIME TO FAILURE, MIN	t_f	22.5			
UNCONFINED COMPRESSIVE STRENGTH, T/SQ FT	q_u	1.09			
UNDRAINED SHEAR STRENGTH, T/SQ FT	s_u				
SENSITIVITY RATIO	S_t				
INITIAL SPECIMEN DIAMETER, IN	D_o	1.38			
INITIAL SPECIMEN HEIGHT, IN.	H_o	3.00			

CLASSIFICATION Organic Silt, OH

LL 347	PL 201	PI 146	G_s 1.86

REMARKS Black. Torvane=.45 TSF. Highly calcareous.

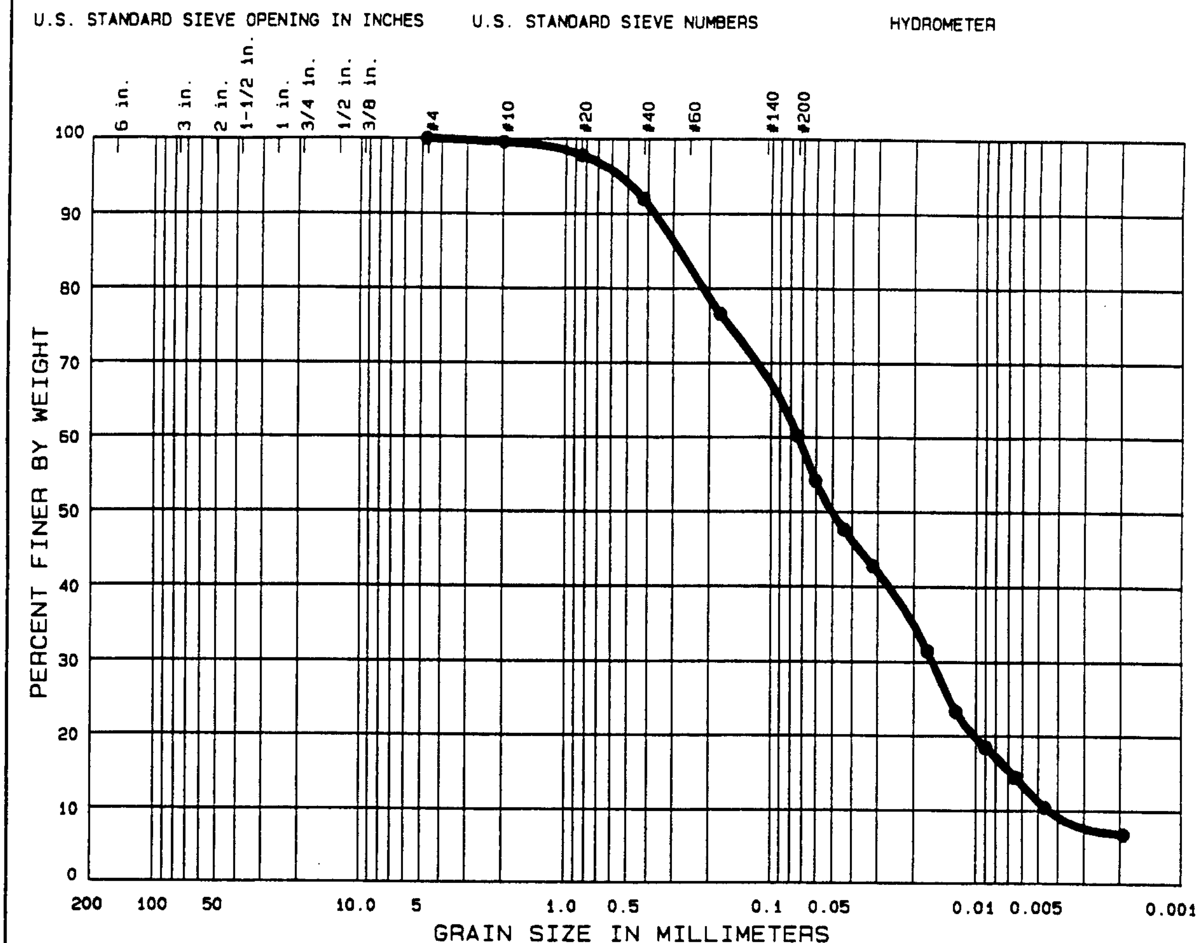
PROJECT	CHASKA; CENCS-IA-92-97-ED-GH		
AREA	MRD LAB NO. : 1535		
BORING NO.	MU 92-172	SAMPLE NO.	W-1
DEPTH EL	29'-31'	DATE	7-7-92

UNCONFINED COMPRESSION TEST REPORT

ENG FORM 1 JUN 65 **3659** *(EM 1110-2-1906)* *(TRANSLUCENT)* GPO : 1966 OF—214-946 PLATE XI-2

Figure 19 FIG D-280

W.O. No. 1535
Req. No. 92-97-ED-GH
Contract No. NA



	% COBBLES	% GRAVEL	% SAND	% SILT OR CLAY	
●	0.0	0.0	39.8	49.0	11.2

	Sample No.	Elev or Depth	Nat W%	LL	PL	PI	C_c	C_u
●	W-1	29'- 31'		347	201	146	0.80	16.4

CLASSIFICATION

● ORGANIC SILT OH

Remarks:	Project CHASKA FLOOD CONTROL
	Lab No. 1535
	Area
	Boring No. 92-172MU Date 7-30-92

GRADATION CURVES

CORPS OF ENGINEERS, MISSOURI RIVER DIVISION LAB
420 SOUTH 18th STREET - OMAHA, NE 68102-2586

Figure 20 FIG D-281

CLASSIFICATION TEST REQUEST

PROJECT: Chaska

MRD LAB. NO.: [redacted] 1535

ACCOMPANYING TEST: Unc., R̄

REQUEST NO.: CENCS-IA92-97-ED-GH

CONTAINER - TYPE: Tube

NO.:

SAMPLE IDENTIFICATION: 92-172 MV W-1 29'-31'

SAMPLE IDENTIFICATION:

Structure: ( ) Brittle (✓) Plastic ( )

Consistency: Undisturbed ( ) Soft (✓) Med ( ) Stiff ( ) Hard

Remolded ( ) Insensitive (✓) Sl. Sens. ( ) Sensitive

PL Thread: Strength (✓) Low ( ) Med ( ) High ( )

Shine (✓) None ( ) Dull ( ) Gloss ( ) H. Gloss ( )

Shake Test ( ) None ( ) Slow ( ) Fast ( ) Rapid ( )

Torvane: 0.45 TSF

Color: black

Disturbance: none

Est. Max. Particle Size:

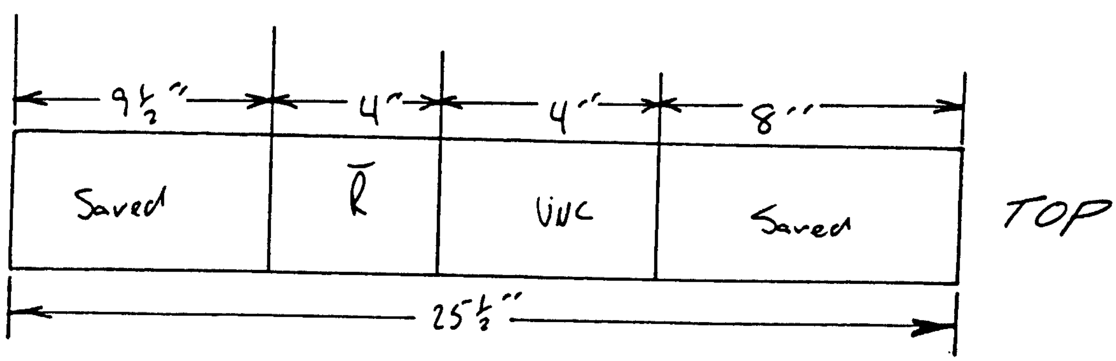
Remarks: decaying organic materiel

Odor: organic smell

Cementation: highly reactive to HCl

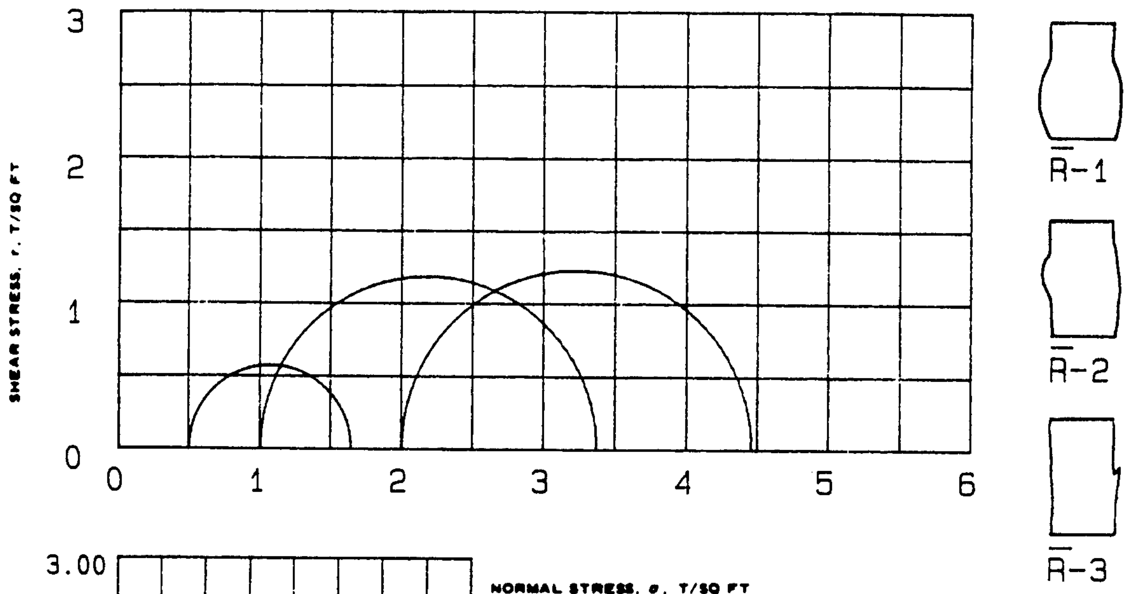
Date Core Opened: 7-7-92

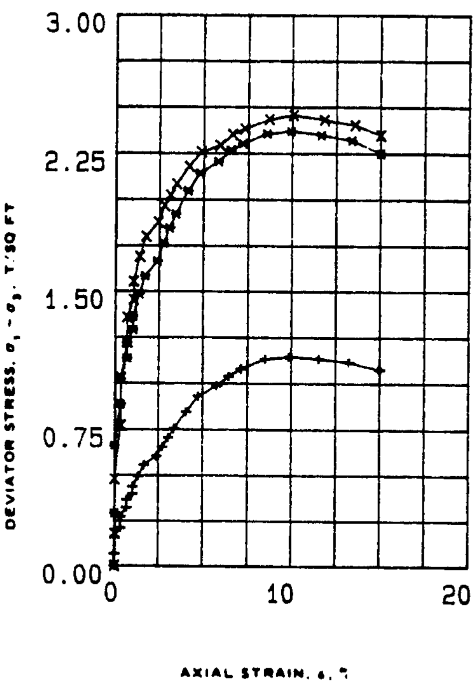
Sketch: (Core description and specimen location)



Technician PK

FIGURE D-282





SPECIMEN NO.			1 (+)	2 (*)	3 (X)	
INITIAL	WATER CONTENT, %	w_o	97.1	94.2	92.5	
	DRY DENSITY LB/CU FT	γd_o	43.5	43.8	44.6	
	SATURATION, %	S_o	98	96	97	
	VOID RATIO	e_o	2.21	2.19	2.13	
BEFORE SHEAR	WATER CONTENT, %	w_c	93.3	86.6	83.1	
	DRY DENSITY LB/CU FT	γd_c	45.7	47.5	50.3	
	SATURATION, %	S_c	100	100	100	
	VOID RATIO	e_c	2.06	1.94	1.78	
	FINAL BACK PRESSURE, T/SQ FT	u_o	3.383	3.383	3.383	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.5	1	2	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	1.144	2.370	2.457	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	1200	1200	1200	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	1.073	2.250	2.348	
INITIAL DIAMETER, IN.		D_o	1.39	1.39	1.4	
INITIAL HEIGHT, IN.		H_o	3	3	3	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Organic Silty Sand, SM

LL 177	PL 107	PI 70	Gs 2.24	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST RBAR

REMARKS: Layered dark and light brown highly calcareous, organic odor, free water on sample and pieces of rotten wood and shells. Torvane=0.34 TSF.

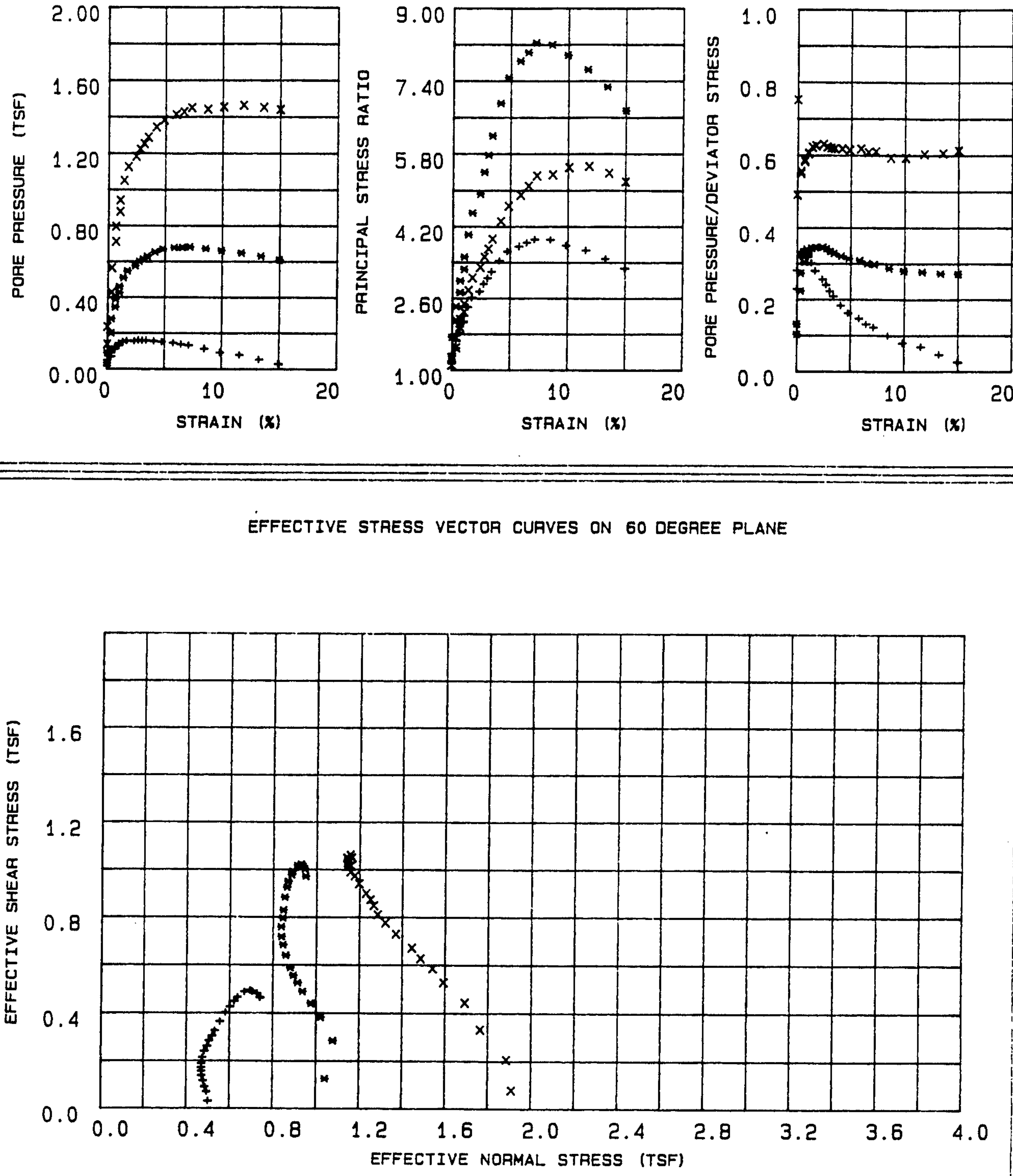
PROJECT	CHASKA; CENCS-IA-92-97-ED-GH
BORING NO 92-173 MU	SAMPLE NO. W-1
DEPTH ELEV	23'-25'
LABORATORY 1535	DATE 08-10-92

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 PREVIOUS EDITION IS OBSOLETE
REV JUNE 1970

TRANSLUCENT *(EM 1110-2-1906)*

FIGURE 12



LEGEND

+ = .5 TSF

* = 1 TSF

X = 2 TSF

PROJECT	CHASKA: CENCS-IA-92-97-ED-GH
BORING NO.	92-173 MU
SAMPLE NO.	W-1
DEPTH/ELEV	23'-25'
MRD LAB NO.	1535

FIGURE 13

R

Table 15 - Triaxial $\bar{R}$ Test Results

Project : CHASKA; CENCS-IA-92-97-ED-GH
Boring Number : 92-173 MU
Sample Number : W-1
Depth : 23'-25'
Confining Pressure : .5 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.00	0.066	0.015	1.136	0.229	0.501	0.029
30	0.00	0.159	0.045	1.350	0.281	0.494	0.069
45	0.34	0.209	0.067	1.483	0.321	0.485	0.090
60	0.34	0.270	0.089	1.656	0.332	0.478	0.116
90	0.68	0.321	0.109	1.819	0.340	0.470	0.138
120	0.68	0.363	0.121	1.959	0.333	0.469	0.157
150	1.02	0.397	0.129	2.068	0.326	0.469	0.171
180	1.02	0.436	0.139	2.209	0.319	0.469	0.188
210	1.36	0.493	0.148	2.402	0.301	0.474	0.213
240	1.70	0.556	0.155	2.611	0.279	0.483	0.240
300	2.38	0.605	0.154	2.748	0.255	0.496	0.261
360	2.72	0.657	0.158	2.920	0.240	0.505	0.284
420	3.05	0.705	0.156	3.051	0.222	0.519	0.304
480	3.39	0.755	0.156	3.195	0.208	0.531	0.326
540	4.07	0.844	0.153	3.435	0.182	0.556	0.364
600	4.75	0.929	0.149	3.646	0.161	0.581	0.401
720	5.77	0.985	0.143	3.760	0.146	0.601	0.425
840	6.45	1.039	0.135	3.844	0.130	0.622	0.448
960	7.13	1.078	0.130	3.915	0.121	0.637	0.465
1080	8.49	1.132	0.111	3.908	0.098	0.669	0.488
1200	9.84	1.144	0.089	3.779	0.078	0.694	0.494
1320	11.54	1.132	0.076	3.668	0.067	0.704	0.489
1440	13.24	1.113	0.050	3.476	0.046	0.726	0.480
1560	14.94	1.075	0.026	3.267	0.025	0.740	0.464
1564	15.00	1.073	0.025	3.260	0.024	0.740	0.463

Table 16 - Triaxial $\bar{R}$ Test Results

Project : CHASKA; CENCS-IA-92-97-ED-GH
Boring Number : 92-173 MU
Sample Number : W-1
Depth : 23'-25'
Confining Pressure : 1 TSF

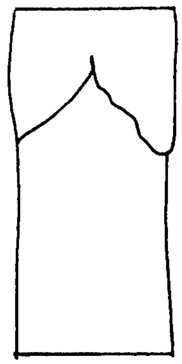
Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.00	0.290	0.030	1.299	0.102	1.042	0.125
30	0.00	0.661	0.086	1.724	0.131	1.078	0.285
45	0.34	0.885	0.198	2.104	0.224	1.021	0.382
60	0.34	1.020	0.278	2.413	0.273	0.975	0.440
90	0.69	1.133	0.344	2.727	0.304	0.936	0.489
120	0.69	1.217	0.388	2.989	0.319	0.913	0.525
150	1.03	1.289	0.426	3.247	0.331	0.893	0.556
180	1.03	1.363	0.459	3.519	0.337	0.879	0.588
210	1.37	1.484	0.509	4.023	0.344	0.858	0.640
240	1.71	1.584	0.547	4.498	0.346	0.845	0.684
300	2.40	1.664	0.575	4.918	0.346	0.837	0.718
360	2.74	1.762	0.600	5.402	0.341	0.836	0.760
420	3.08	1.845	0.613	5.772	0.333	0.844	0.796
480	3.43	1.922	0.630	6.194	0.328	0.846	0.829
540	4.11	2.046	0.654	6.908	0.320	0.852	0.883
600	4.80	2.143	0.669	7.473	0.313	0.862	0.925
720	5.82	2.205	0.678	7.836	0.308	0.868	0.951
840	6.51	2.266	0.678	8.027	0.299	0.883	0.978
960	7.19	2.303	0.682	8.238	0.297	0.888	0.994
1080	8.56	2.356	0.672	8.194	0.286	0.911	1.017
1200	9.93	2.370	0.660	7.961	0.279	0.927	1.023
1320	11.65	2.348	0.647	7.642	0.276	0.934	1.013
1440	13.36	2.319	0.630	7.268	0.272	0.944	1.001
1554	15.00	2.250	0.608	6.742	0.271	0.949	0.971
1554	15.00	2.250	0.608	6.742	0.271	0.949	0.971

Table 17 - Triaxial $\bar{R}$ Test Results

Project : CHASKA; CENCS-IA-92-97-ED-GH
Boring Number : 92-173 MU
Sample Number : W-1
Depth : 23'-25'
Confining Pressure : 2 TSF

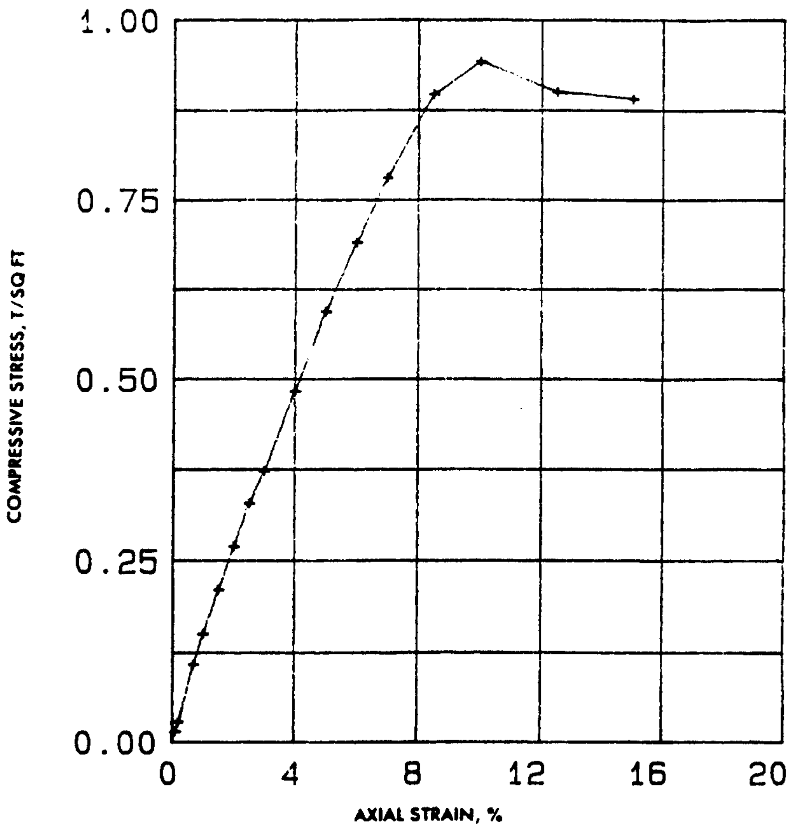
Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.00	0.178	0.134	1.096	0.751	1.910	0.077
30	0.00	0.477	0.233	1.270	0.490	1.885	0.206
45	0.35	0.769	0.426	1.489	0.555	1.764	0.332
60	0.35	1.026	0.563	1.714	0.549	1.691	0.443
90	0.69	1.220	0.710	1.946	0.582	1.592	0.527
120	0.69	1.356	0.795	2.125	0.587	1.541	0.585
150	1.04	1.452	0.876	2.292	0.604	1.484	0.627
180	1.04	1.552	0.940	2.465	0.606	1.444	0.670
210	1.39	1.688	1.049	2.775	0.622	1.369	0.729
240	1.74	1.798	1.125	3.054	0.626	1.320	0.776
300	2.43	1.876	1.181	3.290	0.630	1.283	0.810
360	2.78	1.964	1.221	3.522	0.622	1.265	0.848
420	3.12	2.022	1.251	3.701	0.619	1.250	0.873
480	3.47	2.084	1.287	3.921	0.618	1.229	0.899
540	4.17	2.178	1.343	4.314	0.617	1.196	0.940
[illegible]00	4.86	2.255	1.382	4.652	0.613	1.176	0.973
720	5.90	2.291	1.412	4.895	0.617	1.155	0.989
840	6.59	2.351	1.426	5.093	0.607	1.156	1.015
960	7.29	2.382	1.449	5.320	0.609	1.141	1.028
1080	8.68	2.433	1.440	5.344	0.592	1.162	1.050
1200	10.07	2.457	1.454	5.504	0.592	1.154	1.061
1320	11.80	2.430	1.463	5.526	0.603	1.139	1.049
1440	13.54	2.402	1.451	5.373	0.605	1.144	1.037
1541	15.00	2.348	1.439	5.184	0.613	1.143	1.013
1541	15.00	2.348	1.439	5.184	0.613	1.143	1.013

FAILURE SKETCHES



☐ CONTROLLED STRESS

☒ CONTROLLED STRAIN



TEST NO.						
TYPE OF SPECIMEN UNDISTURBED						
INITIAL	WATER CONTENT	w_o	158.3 %	%	%	%
INITIAL	VOID RATIO	e_o	3.80			
INITIAL	SATURATION	S_o	93 %	%	%	%
INITIAL	DRY DENSITY, LB/CU FT	γ_d	29.1			
TIME TO FAILURE, MIN		t_f	21.5			
UNCONFINED COMPRESSIVE STRENGTH, T/SQ FT		q_u	0.94			
UNDRAINED SHEAR STRENGTH, T/SQ FT		s_u				
SENSITIVITY RATIO		S_t				
INITIAL SPECIMEN DIAMETER, IN		D_o	1.39			
INITIAL SPECIMEN HEIGHT, IN.		H_o	3.00			

CLASSIFICATION Organic Silty Sand, SM

LL 177	PL 107	PI 70	G_s 2.24

REMARKS Layered dark brown and light brown. Torvane=.35 TSF. Highly calcareous.

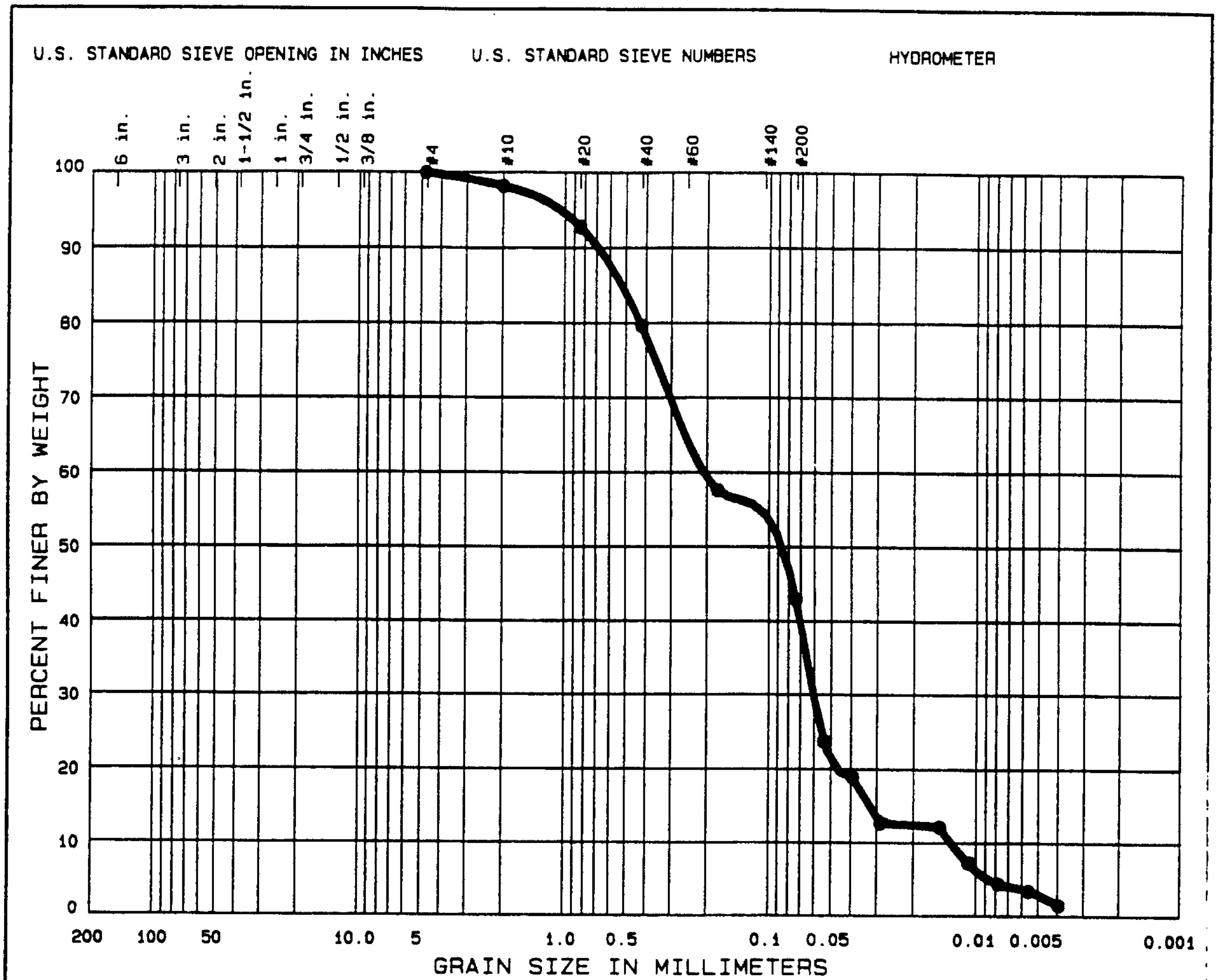
PROJECT	CHASKA: CENCS-IA-92-97-ED-GH		
AREA	MRD LAB NO. : 1535		
BORING NO.	92-173 MU	SAMPLE NO.	W-1
DEPTH EL	23'-25'	DATE	07-08-92

UNCONFINED COMPRESSION TEST REPORT

ENG FORM 1 JUN 65 **3659** *(EM 1110-2-1906)* *(TRANSLUCENT)* GPO : 1966 OF—214-946 PLATE XI-2

Figure 21 FIG D-288

W.O. No. 1535
Req. No. 92-97-ED-GH
Contract No. NA



	% COBBLES	% GRAVEL	% SAND	% SILT OR CLAY	
●	0.0	0.0	57.0	40.1	2.9

	Sample No.	Elev or Depth	Nat W%	LL	PL	PI	C_c	C_u
●	S-1	23'- 25'		177	107	70	1.35	15.6

CLASSIFICATION

● ORGANIC SILTY SAND SM

Remarks:

Project CHASKA FLOOD CONTROL

Lab No. 1535

Area

Boring No. 92-173MU Date 7-30-92

GRADATION CURVES

CORPS OF ENGINEERS, MISSOURI RIVER DIVISION LAB
420 SOUTH 18th STREET - OMAHA, NE 68102-2586

CLASSIFICATION TEST REQUEST

PROJECT: Chaska

MRD LAB. NO.: 1535

ACCOMPANYING TEST: UNC., $\bar{R}$

REQUEST NO.:

CONTAINER - TYPE: Tube

NO.:

SAMPLE IDENTIFICATION: 92-173 MV S-1 23'-25'

SAMPLE IDENTIFICATION:

Structure: ( ) Brittle (✓) Plastic ( )

Consistency: Undisturbed ( ) Soft (✓) Med ( ) Stiff ( ) Hard

Remolded ( ) Insensitive (✓) Sl. Sens. ( ) Sensitive

PL Thread: Strength (✓) Low ( ) Med ( ) High ( )

Shine (✓) None ( ) Dull ( ) Gloss ( ) H. Gloss ( )

Shake Test ( ) None ( ) Slow ( ) Fast ( ) Rapid ( )

Torvane: 0.35 TSF

Odor: organic smell

Color: dark brown + light brown layered

Cementation: highly reactive to HCl

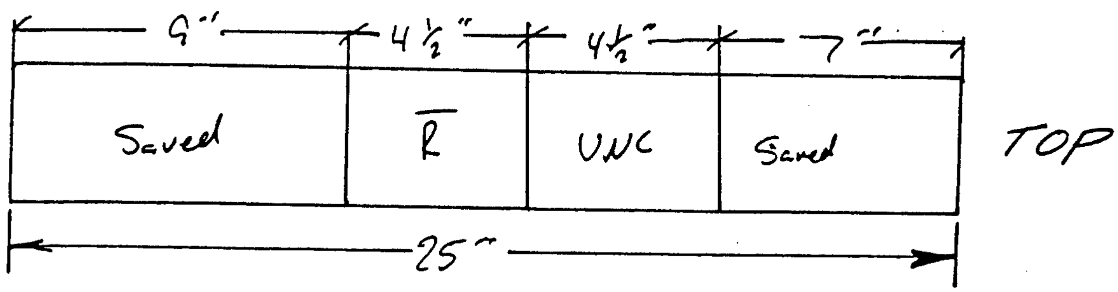
Disturbance: none

Date Core Opened: 7-8-92

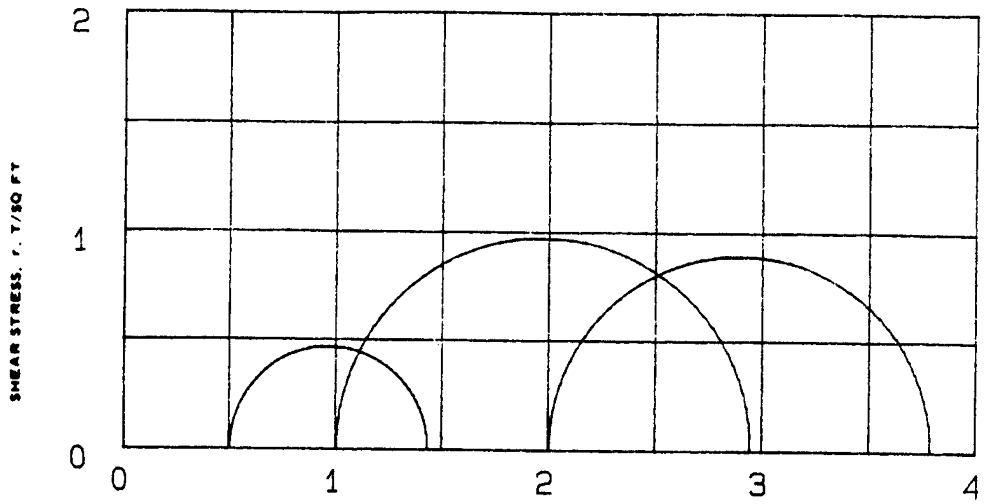
Est. Max. Particle Size:

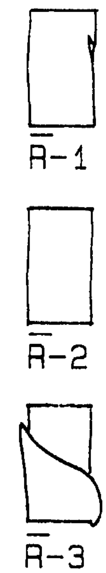
Sketch: (Core description and specimen location)

Remarks: ~~Some~~ lots of organic material present
Some free standing water on plastic

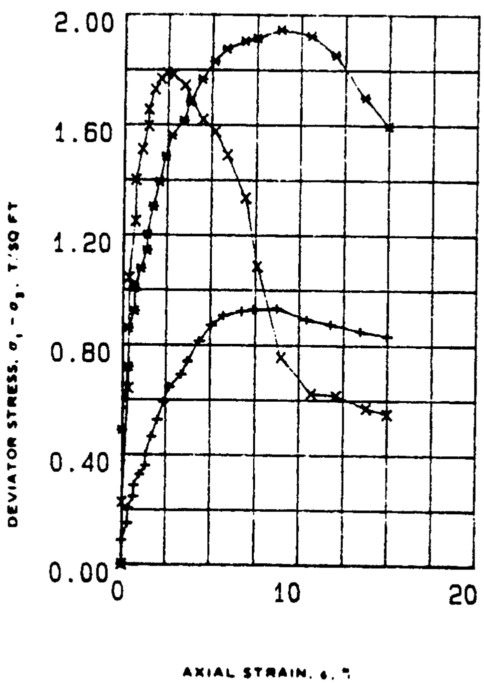


Technician





NORMAL STRESS, σ, T/SQ FT



			1 (+)	2 (*)	3 (X)
SPECIMEN NO.			1 (+)	2 (*)	3 (X)
INITIAL	WATER CONTENT, %	w_o	111	98.4	93.6
	DRY DENSITY LB/CU FT	γd_o	38.5	41.7	43.3
	SATURATION, %	S_o	92	91	91
	VOID RATIO	e_o	2.9	2.61	2.47
BEFORE SHEAR	WATER CONTENT, %	w_c	117.4	98.7	94
	DRY DENSITY LB/CU FT	γd_c	39.9	44.8	48.2
	SATURATION, %	S_c	100	100	100
	VOID RATIO	e_c	2.77	2.36	2.12
	FINAL BACK PRESSURE, T/SQ FT	u_o	3.383	3.383	3.383
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.5	1	2
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	0.932	1.946	1.788
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	1080	1080	300
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	0.832	1.596	0.548
INITIAL DIAMETER, IN.		D_o	1.39	1.4	1.4
INITIAL HEIGHT, IN.		H_o	3.01	3.01	3

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Organic Silty Sand, SM

LL 157	PL 88	PI 69	G_s 2.41

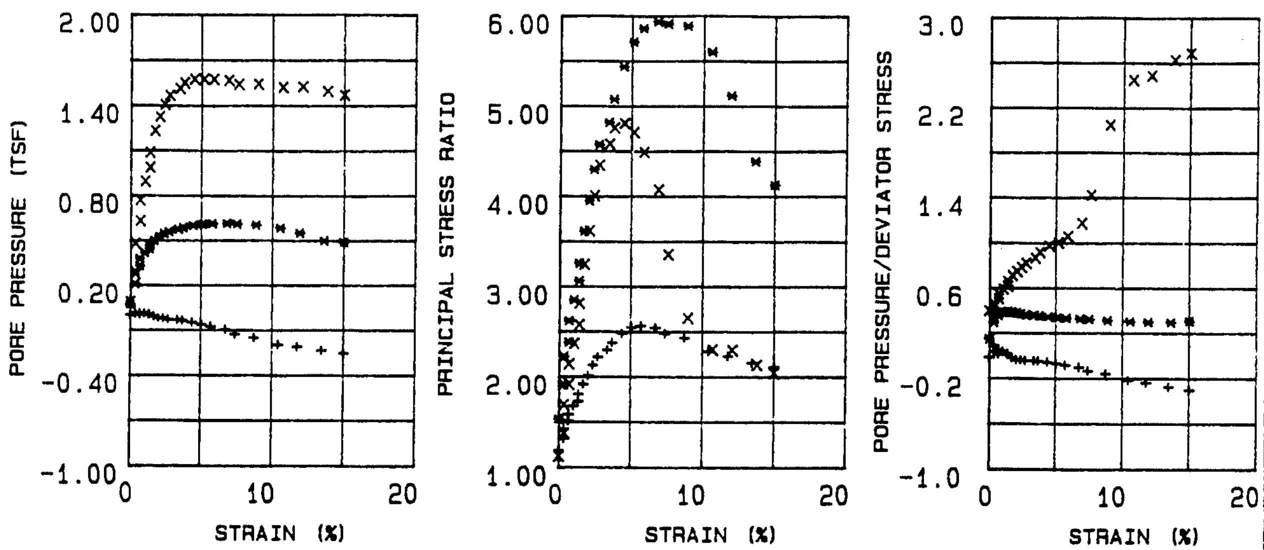
TYPE OF SPECIMEN	UNDISTURBED
TYPE OF TEST	RBAR
PROJECT	CHASKA: CENCS-IA-92-97-ED-GH
BORING NO	92-173 MU
SAMPLE NO.	W-3
DEPTH ELEV	40'-42'
LABORATORY	1535
DATE	08-13-92

REMARKS: Layered black and light brown, highly calcareous, organic odor. No Torvane.

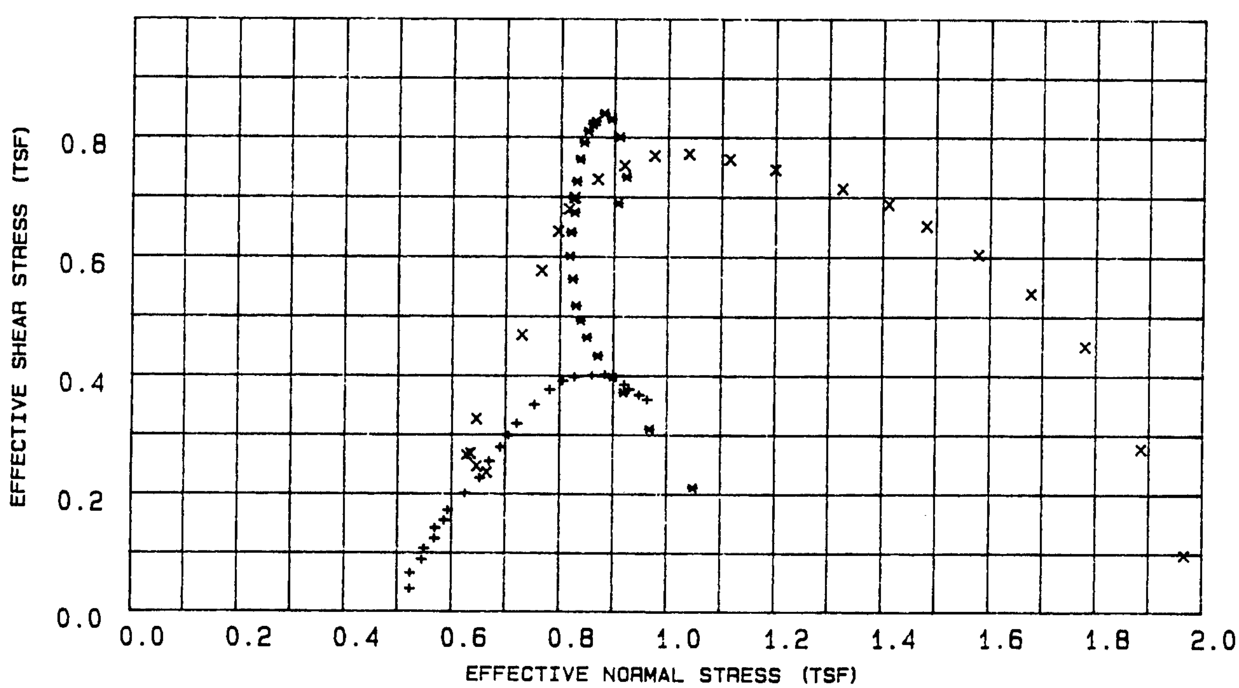
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

FIGURE 14



EFFECTIVE STRESS VECTOR CURVES ON 60 DEGREE PLANE



LEGEND

+ = .5 TSF

* = 1 TSF

X = 2 TSF

PROJECT	CHASKA: CENCS-IA-92-97-ED-GH
BORING NO.	92-173 MU
SAMPLE NO.	W-3
DEPTH/ELEV	40'-42'
MRD LAB NO.	1535

FIGURE 15

FIGURE D-292

R

Table 18 - Triaxial $\overline{R}$ Test Results

Project : CHASKA; CENCS-IA-92-97-ED-GH
Boring Number : 92-173 MU
Sample Number : W-3
Depth : 40'-42'
Confining Pressure : .5 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.00	0.088	-0.001	1.176	-0.016	0.523	0.038
30	0.34	0.150	0.014	1.309	0.091	0.523	0.065
45	0.34	0.204	0.006	1.414	0.032	0.545	0.088
60	0.67	0.247	0.012	1.506	0.047	0.549	0.107
90	0.67	0.288	0.003	1.579	0.011	0.568	0.124
120	1.01	0.328	0.012	1.672	0.036	0.569	0.142
150	1.34	0.360	0.003	1.724	0.009	0.586	0.155
180	1.34	0.398	0.005	1.803	0.013	0.593	0.172
210	1.68	0.466	-0.010	1.913	-0.021	0.625	0.201
240	2.02	0.527	-0.022	2.010	-0.041	0.652	0.227
300	2.35	0.590	-0.024	2.125	-0.041	0.670	0.255
360	2.69	0.646	-0.031	2.217	-0.047	0.691	0.279
420	3.36	0.692	-0.035	2.295	-0.049	0.706	0.299
480	3.70	0.740	-0.038	2.375	-0.051	0.721	0.319
[illegible]40	4.37	0.814	-0.051	2.477	-0.062	0.753	0.351
600	5.04	0.872	-0.065	2.545	-0.074	0.781	0.377
720	5.71	0.907	-0.080	2.564	-0.088	0.805	0.392
840	6.72	0.923	-0.099	2.540	-0.107	0.827	0.398
960	7.39	0.929	-0.130	2.473	-0.140	0.860	0.401
1080	8.74	0.932	-0.153	2.426	-0.164	0.884	0.402
1200	10.42	0.892	-0.199	2.277	-0.222	0.920	0.385
1320	11.76	0.874	-0.213	2.225	-0.243	0.929	0.377
1440	13.45	0.850	-0.238	2.153	-0.279	0.948	0.367
1551	15.00	0.832	-0.256	2.101	-0.308	0.963	0.359

Table 19 - Triaxial $\bar{R}$ Test Results

Project : CHASKA; CENCS-IA-92-97-ED-GH
Boring Number : 92-173 MU
Sample Number : W-3
Depth : 40'-42'
Confining Pressure : 1 TSF

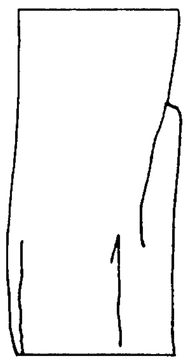
Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.00	0.489	0.072	1.527	0.148	1.049	0.211
30	0.34	0.719	0.210	1.910	0.292	0.968	0.310
45	0.34	0.861	0.294	2.221	0.342	0.919	0.372
60	0.68	0.923	0.331	2.380	0.359	0.898	0.398
90	0.68	1.006	0.379	2.619	0.377	0.870	0.434
120	1.02	1.077	0.418	2.852	0.389	0.849	0.465
150	1.36	1.143	0.446	3.064	0.391	0.837	0.493
180	1.36	1.201	0.468	3.257	0.390	0.829	0.518
210	1.70	1.304	0.501	3.614	0.385	0.822	0.563
240	2.04	1.393	0.528	3.949	0.379	0.817	0.601
300	2.39	1.485	0.549	4.295	0.370	0.819	0.641
360	2.73	1.562	0.562	4.570	0.360	0.825	0.674
420	3.41	1.616	0.577	4.818	0.357	0.823	0.697
480	3.75	1.683	0.588	5.079	0.350	0.829	0.726
540	4.43	1.767	0.602	5.439	0.341	0.835	0.763
600	5.11	1.832	0.611	5.712	0.334	0.842	0.791
720	5.79	1.876	0.614	5.863	0.328	0.850	0.810
840	6.81	1.905	0.614	5.938	0.323	0.858	0.822
960	7.50	1.916	0.610	5.911	0.319	0.864	0.827
1080	8.86	1.946	0.602	5.887	0.310	0.880	0.840
1200	10.56	1.923	0.582	5.597	0.303	0.894	0.830
1320	11.93	1.853	0.549	5.113	0.297	0.910	0.800
1440	13.63	1.698	0.498	4.384	0.294	0.922	0.733
1536	15.00	1.596	0.488	4.122	0.307	0.907	0.689

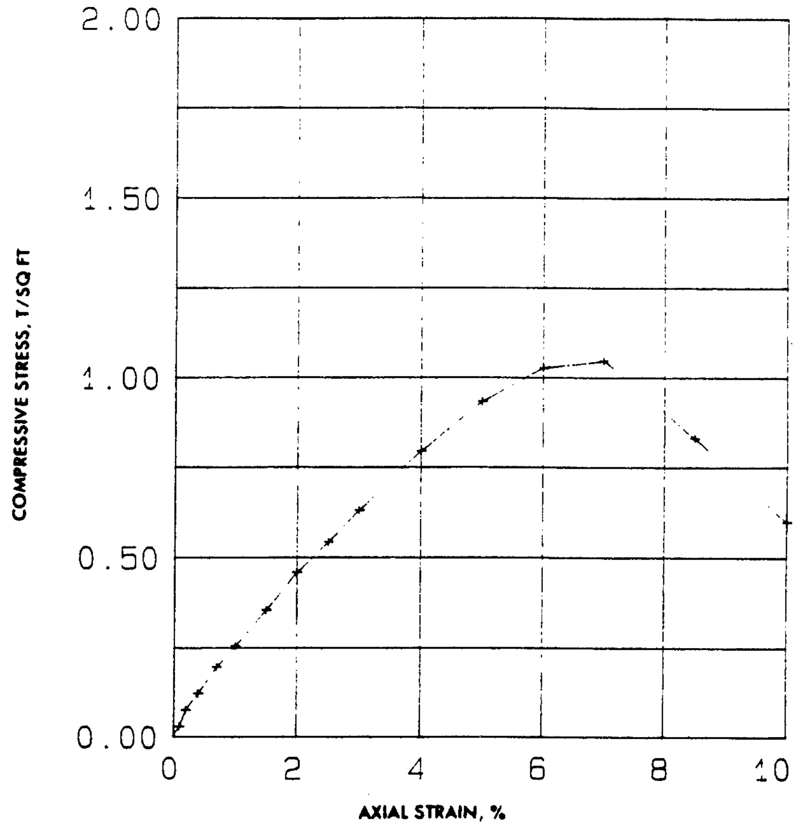
Table 20 - Triaxial $\bar{R}$ Test Results

Project : CHASKA; CENCS-IA-92-97-ED-GH
Boring Number : 92-173 MU
Sample Number : W-3
Depth : 40'-42'
Confining Pressure : 2 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.00	0.225	0.089	1.118	0.397	1.967	0.097
30	0.35	0.641	0.274	1.372	0.428	1.885	0.277
45	0.35	1.042	0.479	1.685	0.460	1.779	0.450
60	0.69	1.249	0.632	1.913	0.507	1.677	0.539
90	0.69	1.399	0.768	2.136	0.550	1.578	0.604
120	1.04	1.510	0.893	2.364	0.592	1.481	0.652
150	1.38	1.595	0.985	2.571	0.618	1.410	0.688
180	1.38	1.655	1.086	2.811	0.657	1.324	0.714
210	1.73	1.729	1.230	3.245	0.712	1.198	0.746
240	2.07	1.768	1.324	3.616	0.749	1.114	0.763
300	2.42	1.788	1.405	4.003	0.786	1.038	0.772
360	2.76	1.783	1.467	4.342	0.823	0.974	0.769
420	3.46	1.743	1.513	4.577	0.868	0.918	0.752
480	3.80	1.689	1.550	4.755	0.918	0.868	0.729
540	4.49	1.617	1.575	4.807	0.975	0.825	0.698
600	5.18	1.573	1.575	4.705	1.002	0.815	0.679
720	5.87	1.488	1.573	4.486	1.058	0.795	0.642
840	6.91	1.334	1.565	4.068	1.174	0.765	0.576
960	7.60	1.084	1.539	3.352	1.421	0.729	0.468
1080	8.98	0.754	1.542	2.646	2.044	0.645	0.326
1200	10.71	0.622	1.520	2.295	2.445	0.634	0.268
1320	12.09	0.614	1.525	2.292	2.484	0.627	0.265
1440	13.82	0.569	1.495	2.126	2.628	0.646	0.246
1521	15.00	0.548	1.470	2.035	2.687	0.665	0.236

FAILURE SKETCHES





☐ CONTROLLED STRESS

☒ CONTROLLED STRAIN

TEST NO.						
TYPE OF SPECIMEN	UNDISTURBED					
INITIAL	WATER CONTENT	w_o	90.0 %	%	%	%
INITIAL	VOID RATIO	e_o	2.32			
INITIAL	SATURATION	S_o	93 %	%	%	%
INITIAL	DRY DENSITY, LB/CU FT	γ_d	45.3			
TIME TO FAILURE, MIN		t_f	16.8			
UNCONFINED COMPRESSIVE STRENGTH, T/SQ FT		q_u	1.05			
UNDRAINED SHEAR STRENGTH, T/SQ FT		s_u				
SENSITIVITY RATIO		S_t				
INITIAL SPECIMEN DIAMETER, IN		D_o	1.40			
INITIAL SPECIMEN HEIGHT, IN.		H_o	3.01			

CLASSIFICATION Organic Silty Sand, SM

LL	PL	PI	G_s
157	88	69	2.41

REMARKS layered black and light brown. No torvane. Highly calcareous.

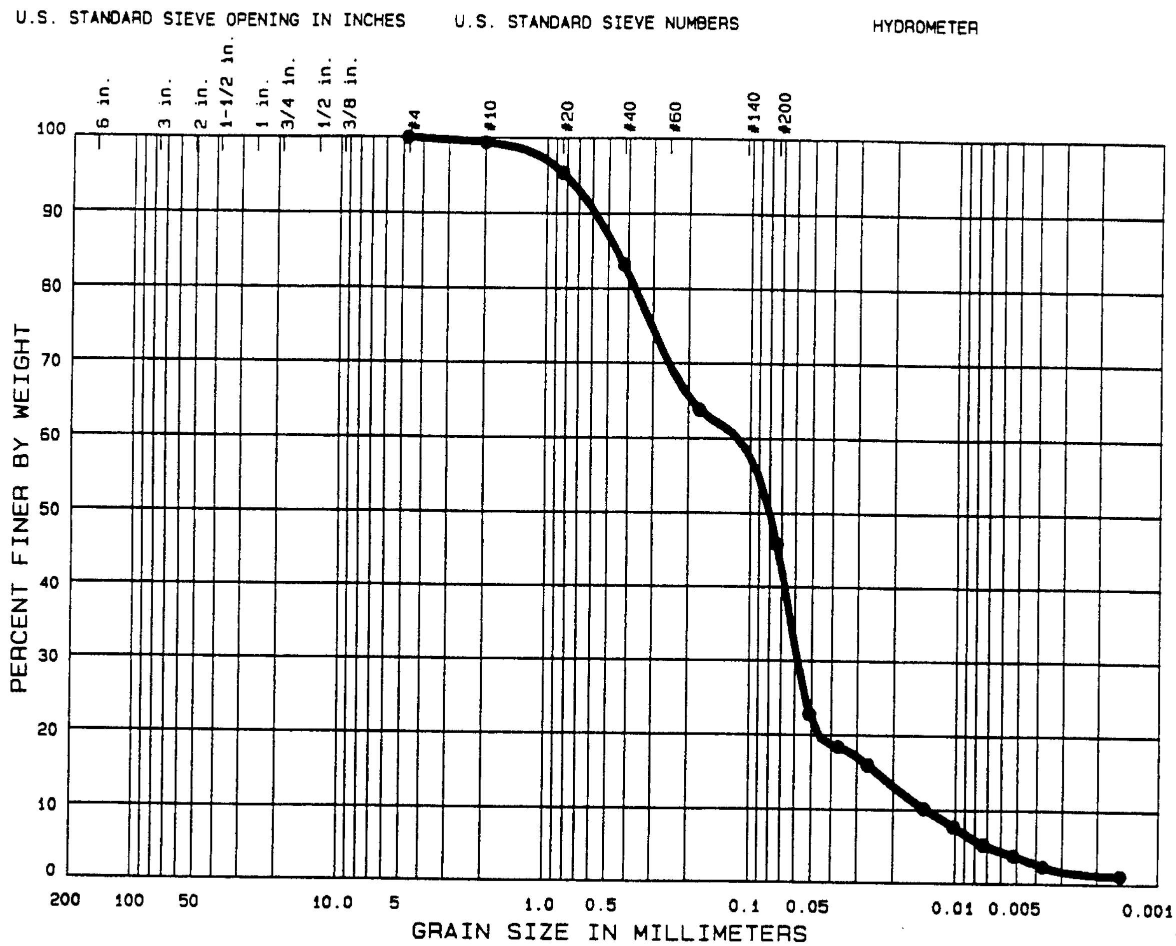
PROJECT	CHASKA; CENCS-IA-92-97-ED-GH		
AREA	MRD LAB NO. : 1535		
BORING NO.	92-173 MU	SAMPLE NO.	W-3
DEPTH EL	40'-42'	DATE	07-14-92

UNCONFINED COMPRESSION TEST REPORT

ENG FORM 1 JUN 65 **3659** *(EM 1110-2-1906)* *(TRANSLUCENT)* GPO · 1964 OF—214-946 PLATE XI-2

Figure 23 FIG D-296

W.O. No. 1535
Req. No. 92-97-ED-GH
Contract No. NA



	% COBBLES	% GRAVEL	% SAND	% SILT OR CLAY	
●	0.0	0.0	54.2	42.2	3.6

	Sample No.	Elev or Depth	Nat W%	LL	PL	PI	C_c	C_u
●	S-3	40'- 42'		157	88	69	2.15	8.1

CLASSIFICATION

● ORGANIC SILTY SAND SM

Remarks:

Project CHASKA FLOOD CONTROL

Lab No. 1535

Area

Boring No. 92-173MU Date 7-30-92

GRADATION CURVES

CORPS OF ENGINEERS, MISSOURI RIVER DIVISION LAB
420 SOUTH 18th STREET - OMAHA, NE 68102-2586

Figure 24 FIGURE D-297

CLASSIFICATION TEST REQUEST

PROJECT: Chaske

MRD LAB. NO.:

ACCOMPANYING TEST: UNC, R

REQUEST NO.:

CONTAINER - TYPE: Tube

NO.:

SAMPLE IDENTIFICATION: 92-173MV 5-3 40'-42'

SAMPLE IDENTIFICATION:

Structure: ( ) Brittle (✓) Plastic ( )

Consistency: Undisturbed ( ) Soft (✓) Med ( ) Stiff ( ) Hard

Remolded ( ) Insensitive (✓) Sl. Sens. ( ) Sensitive

PL Thread: Strength (✓) Low (✓) Med ( ) High ( )

Shine (✓) None ( ) Dull ( ) Gloss ( ) H. Gloss ( )

Shake Test ( ) None ( ) Slow ( ) Fast ( ) Rapid ( )

Torvane:

Color: black + light Brown layered

Disturbance: none.

Est. Max. Particle Size:

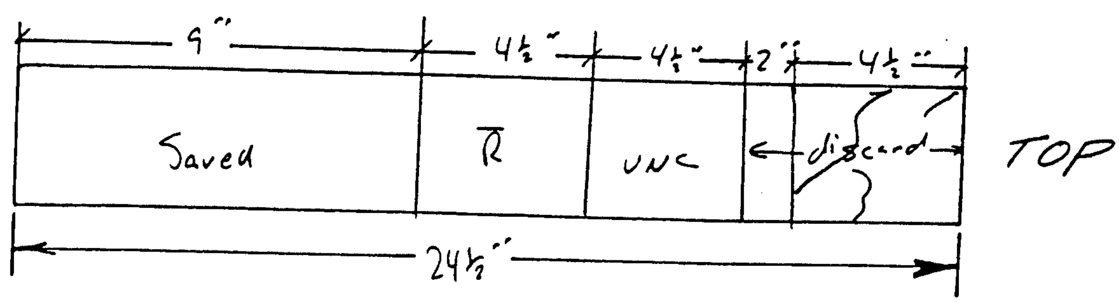
Remarks: Some organics + shells

Odor: organic odor

Cementation: highly reactive to HCl

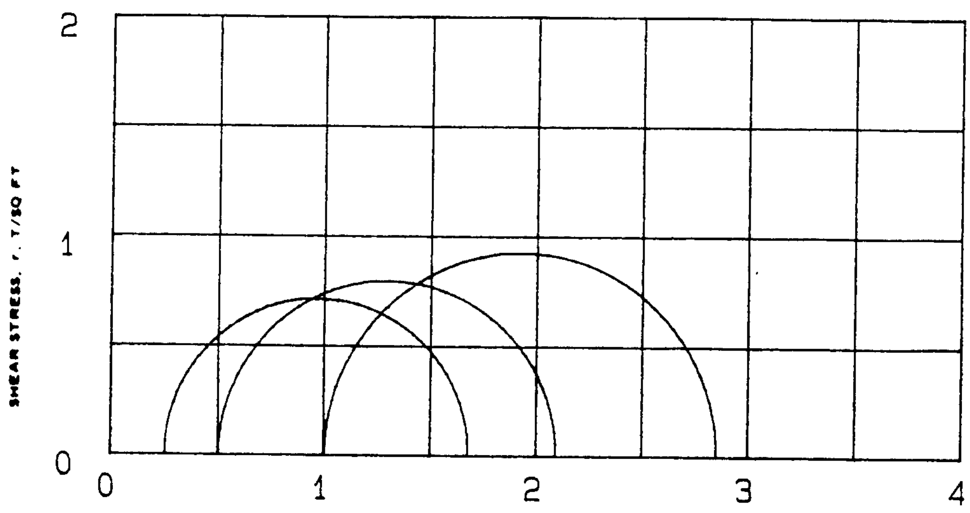
Date Core Opened: 7-13-92

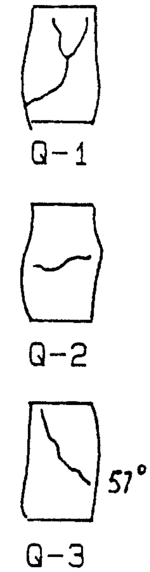
Sketch: (Core description and specimen location)

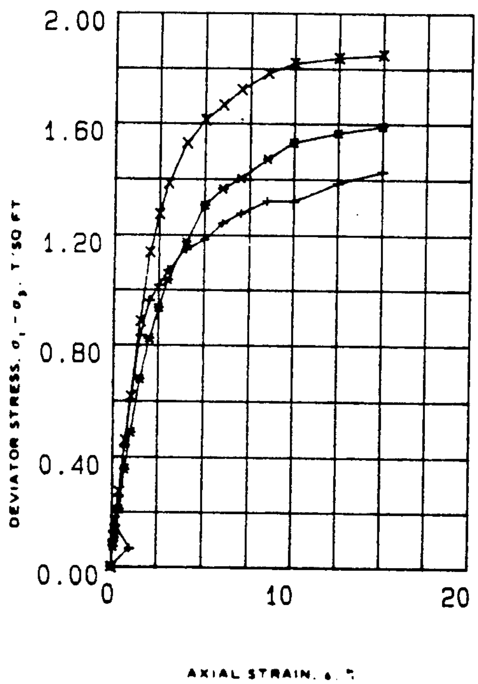


Technician [signature]

FIGURE D-298







SPECIMEN NO.			1 (+)	2 (*)	3 (X)
INITIAL	WATER CONTENT, %	w_o	81.2	84.8	81.9
	DRY DENSITY LB/CU FT	γ_{d_o}	50.2	48.0	44.9
	SATURATION, %	S_o	94.0	92.0	81.0
	VOID RATIO	e_o	2.27	2.42	2.66
BEFORE SHEAR	WATER CONTENT, %	w_c	79.7	83.9	81.3
	DRY DENSITY LB/CU FT	γ_{d_c}	50.2	48.1	44.7
	SATURATION, %	S_c	92.0	91.0	80.0
	VOID RATIO	e_c	2.27	2.41	2.67
	FINAL BACK PRESSURE, T/SQ FT	u_o	0.0	0.0	0.0
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	0.3	0.5	1.0
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	1.43	1.59	1.85
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	31.0	31.5	30.8
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	1.43	1.59	1.85
INITIAL DIAMETER, IN		D_o	1.39	1.39	1.47
INITIAL HEIGHT, IN.		H_o	2.99	3.00	3.00

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Elastic Silt, MH

LL 67 | PL 57 | PI 10 | G_s 2.63

TYPE OF SPECIMEN UNDISTURBED | TYPE OF TEST Q

REMARKS White gray and light brown. Torvane = 0.30 TSF. Slight calcareous, slight odorous. Samples have wood chips throughout.

PROJECT CHASKA FLOOD CONTROL; CENCS-IA-93-ED-GH

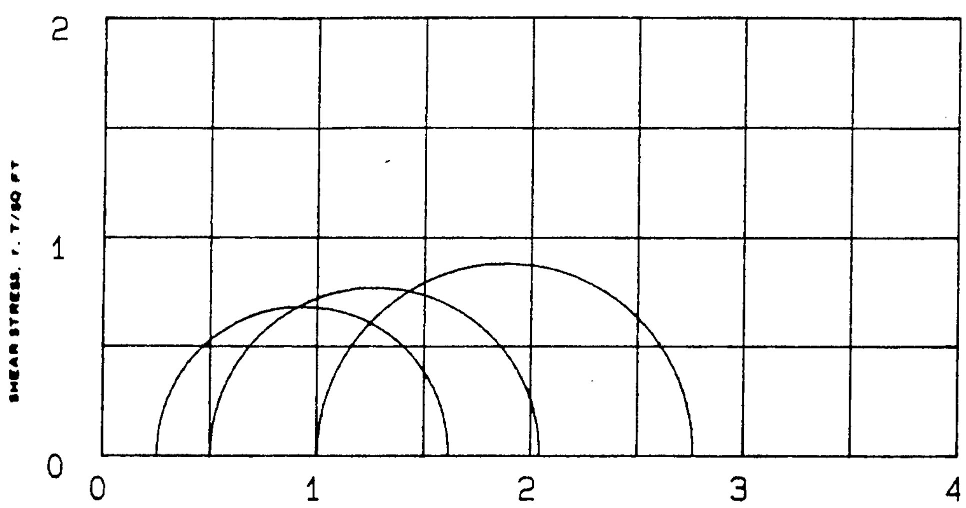
BORING NO 92-195MU | SAMPLE NO. W-1

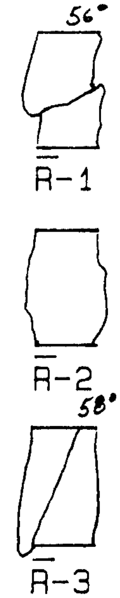
DEPTH ELEV 2.0'-4.0'

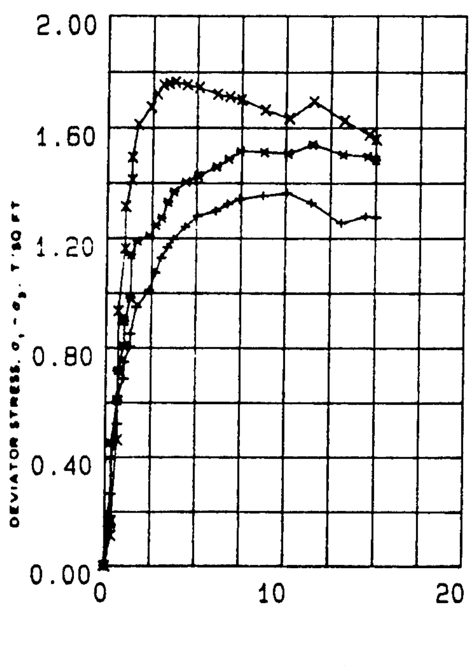
LABORATORY 1897 | DATE 2/3/93

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906) FIGURE 1







NORMAL STRESS, σ, T/SQ FT

SPECIMEN NO.			1 (+)	2 (*)	3 (X)	
INITIAL	WATER CONTENT, %	w_o	91.1	89.1	91.9	
	DRY DENSITY LB/CU FT	γ_{d_o}	46.9	47.5	45.9	
	SATURATION, %	S_o	96	95	94	
	VOID RATIO	e_o	2.5	2.45	2.58	
BEFORE SHEAR	WATER CONTENT, %	w_c	93	91.4	93.2	
	DRY DENSITY LB/CU FT	γ_{d_c}	48.2	48.9	47.9	
	SATURATION, %	S_c	100	100	100	
	VOID RATIO	e_c	2.41	2.36	2.43	
	FINAL BACK PRESSURE, T/SQ FT	u_o	4.103	4.103	4.103	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.25	.5	1	
MAXIMUM DEVIATOR STRESS T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	1.364	1.539	1.764	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	1200	1320	480	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	1.275	1.483	1.557	
INITIAL DIAMETER IN		D_o	1.4	1.39	1.4	
INITIAL HEIGHT, IN		H_o	3.01	2.99	2.99	
B-Value			1.0	1.0	1.0	

CONTROLLED- STRAIN TEST

Description of Specimens: Elastic Silt, MH

LL 67	PL 57	PI 10	G_s 2.63	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST RBAR

REMARKS White gray and light gray. Torvane = 0.30 TSF. Slightly calcareous, slightly odorous. Samples have wood chips throughout.

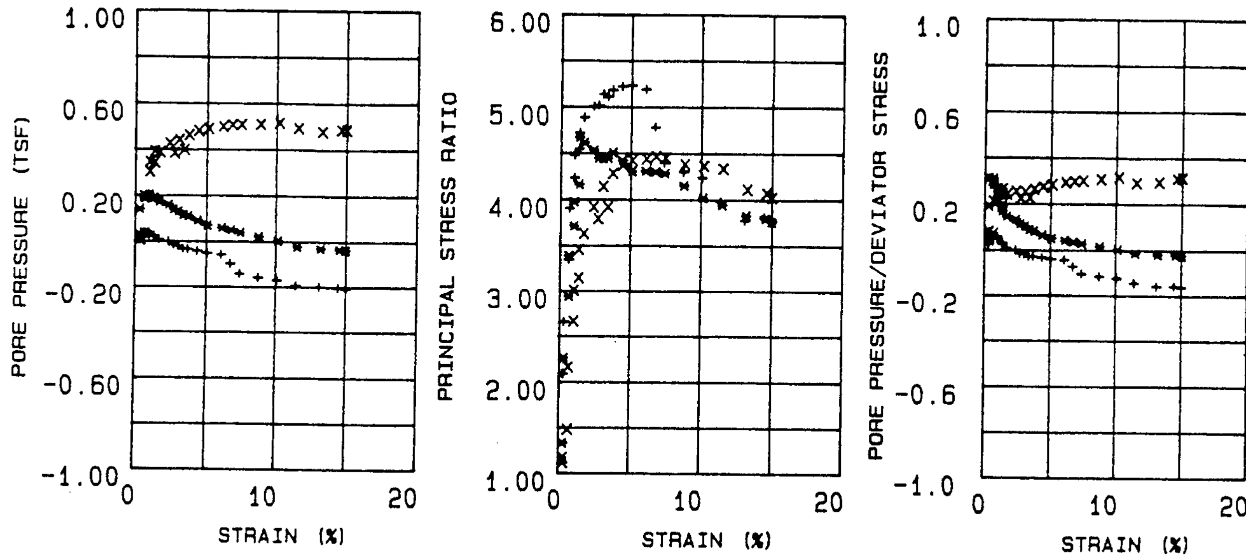
PROJECT	CHASKA FLOOD C.P.; IA-93-30
BORING NO 92-195 MU	SAMPLE NO. W-1
DEPTH ELEV	2'-4'
LABORATORY 1897	DATE 2-1-93

TRIAXIAL COMPRESSION TEST REPORT

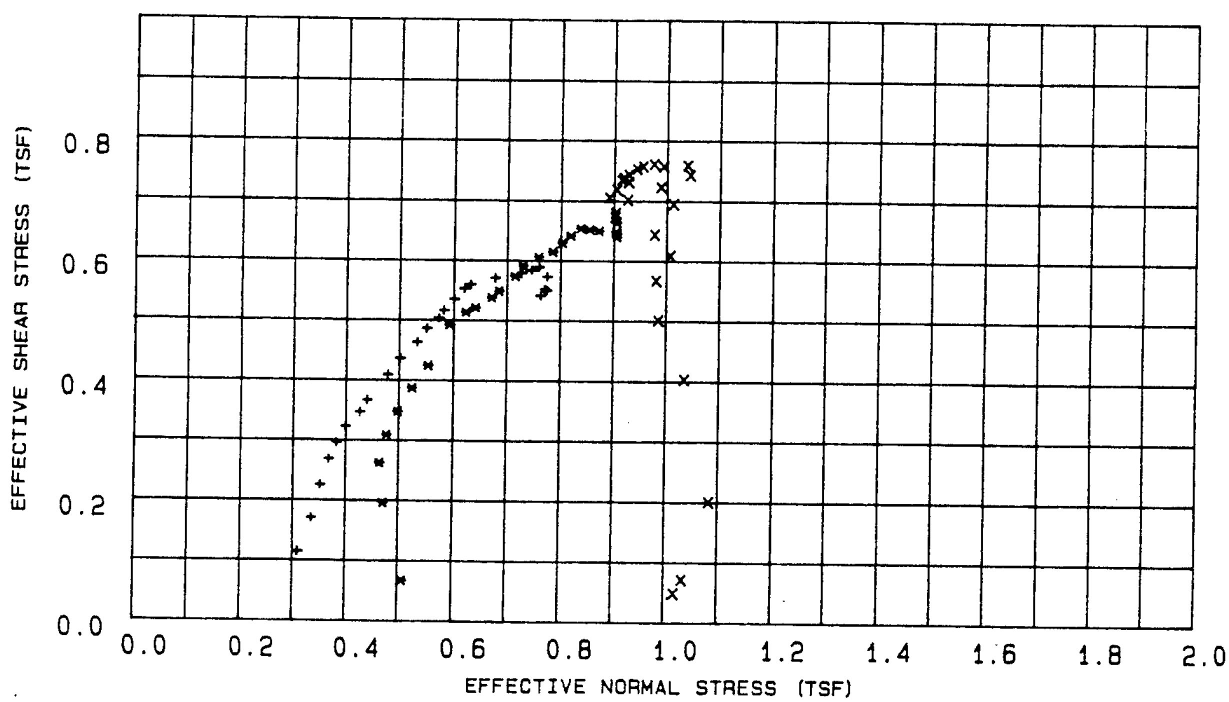
ENG FORM NO 2089 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)
REV JUNE 1970

FIGURE 2

FIGURE D-300



EFFECTIVE STRESS VECTOR CURVES ON 60 DEGREE PLANE



LEGEND

+ = .25 TSF

* = .5 TSF

X = 1 TSF

PROJECT	CHASKA FLOOD C.P.; IA-93-30
BORING NO.	92-195 MU
SAMPLE NO.	W-1
DEPTH/ELEV	2'-4'
MRD LAB NO.	1897

FIGURE 3

FIGURE D-301

Table 1 - Triaxial $\bar{R}$ Test Results

Project : CHASKA FLOOD C.P.;IA-93-30
Boring Number : 92-195 MU
Sample Number : W-1
Depth : 2'-4'
Confining Pressure : .25 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.34	0.265	0.006	2.087	0.025	0.310	0.114
30	0.34	0.393	0.012	2.654	0.032	0.335	0.170
45	0.67	0.522	0.027	3.343	0.053	0.352	0.225
60	0.67	0.621	0.036	3.902	0.058	0.368	0.268
90	1.01	0.687	0.037	4.231	0.055	0.383	0.296
120	1.01	0.748	0.035	4.473	0.047	0.400	0.323
150	1.34	0.804	0.023	4.542	0.029	0.426	0.347
180	1.34	0.851	0.021	4.714	0.025	0.440	0.367
210	1.68	0.948	0.006	4.883	0.007	0.479	0.409
240	2.35	1.010	-0.002	5.007	-0.002	0.502	0.436
300	2.69	1.074	-0.017	5.016	-0.016	0.533	0.463
360	3.02	1.127	-0.022	5.138	-0.019	0.551	0.486
420	3.36	1.166	-0.034	5.108	-0.029	0.573	0.503
480	3.69	1.196	-0.036	5.181	-0.030	0.582	0.516
540	4.36	1.241	-0.044	5.221	-0.035	0.601	0.535
600	5.04	1.280	-0.053	5.232	-0.041	0.620	0.553
720	6.04	1.298	-0.060	5.190	-0.046	0.631	0.560
840	6.71	1.323	-0.100	4.778	-0.075	0.677	0.571
960	7.39	1.342	-0.145	4.394	-0.108	0.727	0.579
1080	8.73	1.354	-0.161	4.298	-0.118	0.746	0.584
1200	10.07	1.364	-0.172	4.233	-0.126	0.760	0.589
1320	11.41	1.327	-0.196	3.977	-0.147	0.775	0.573
1440	13.09	1.253	-0.202	3.771	-0.161	0.762	0.541
1560	14.43	1.278	-0.205	3.808	-0.160	0.771	0.552
1600	15.00	1.275	-0.210	3.773	-0.164	0.775	0.550

Table 2 - Triaxial $\bar{R}$ Test Results

Project : CHASKA FLOOD C.P.;IA-93-30
Boring Number : 92-195 MU
Sample Number : W-1
Depth : 2'-4'
Confining Pressure : .5 TSF

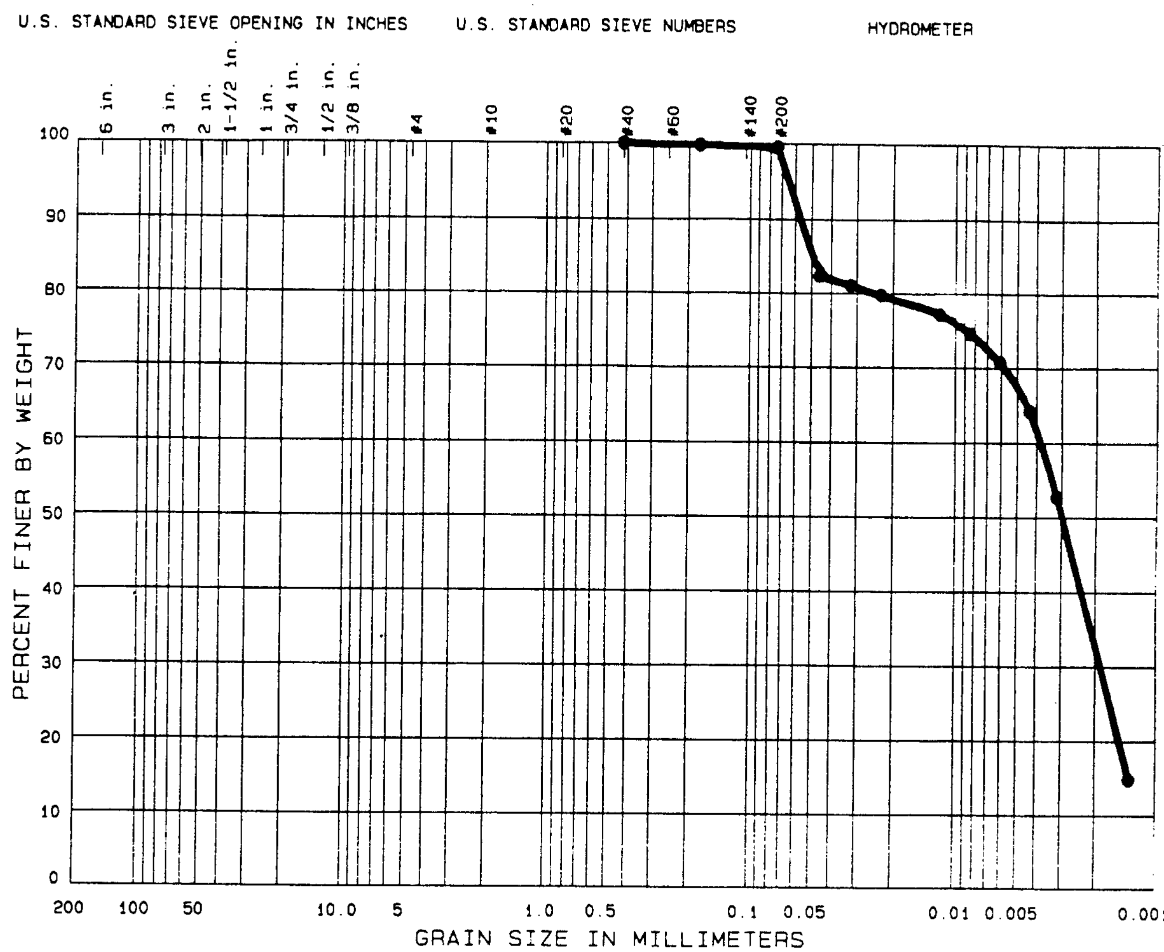
Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.34	0.155	0.030	1.329	0.191	0.508	0.067
30	0.34	0.453	0.141	2.262	0.312	0.471	0.196
45	0.68	0.607	0.186	2.935	0.308	0.464	0.262
60	0.68	0.717	0.200	3.391	0.280	0.477	0.309
90	1.01	0.807	0.202	3.711	0.251	0.498	0.348
120	1.01	0.898	0.198	3.972	0.221	0.524	0.387
150	1.35	0.982	0.189	4.161	0.193	0.554	0.424
180	1.35	1.139	0.189	4.667	0.167	0.593	0.492
210	1.69	1.189	0.171	4.610	0.144	0.623	0.513
240	2.36	1.208	0.158	4.528	0.131	0.641	0.521
300	2.70	1.247	0.138	4.441	0.111	0.671	0.538
360	3.04	1.273	0.130	4.436	0.102	0.685	0.549
420	3.38	1.331	0.114	4.445	0.086	0.715	0.574
480	3.72	1.369	0.109	4.506	0.080	0.730	0.591
540	4.39	1.404	0.089	4.419	0.064	0.759	0.606
600	5.07	1.425	0.068	4.301	0.049	0.785	0.615
720	6.08	1.459	0.058	4.304	0.040	0.803	0.630
840	6.76	1.487	0.049	4.298	0.033	0.819	0.642
960	7.43	1.515	0.038	4.280	0.026	0.837	0.654
1080	8.78	1.511	0.020	4.149	0.014	0.854	0.652
1200	10.14	1.506	0.001	4.017	0.001	0.872	0.650
1320	11.49	1.539	-0.024	3.939	-0.015	0.905	0.664
1440	13.18	1.502	-0.032	3.826	-0.021	0.904	0.648
1560	14.53	1.495	-0.035	3.793	-0.023	0.905	0.645
1593	15.00	1.483	-0.038	3.756	-0.025	0.905	0.640

Table 3 - Triaxial $\bar{R}$ Test Results

Project : CHASKA FLOOD C.P.;IA-93-30
Boring Number : 92-195 MU
Sample Number : W-1
Depth : 2'-4'
Confining Pressure : 1 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.34	0.112	0.009	1.113	0.078	1.019	0.048
30	0.34	0.165	0.007	1.166	0.044	1.034	0.071
45	0.68	0.463	0.032	1.479	0.070	1.083	0.200
60	0.68	0.933	0.196	2.160	0.210	1.035	0.403
90	1.02	1.161	0.302	2.662	0.260	0.985	0.501
120	1.02	1.314	0.345	3.005	0.263	0.980	0.567
150	1.36	1.411	0.342	3.144	0.243	1.007	0.609
180	1.36	1.492	0.392	3.455	0.264	0.977	0.644
210	1.70	1.611	0.387	3.630	0.241	1.012	0.695
240	2.38	1.674	0.426	3.918	0.255	0.988	0.723
300	2.72	1.721	0.383	3.790	0.223	1.043	0.743
360	3.06	1.754	0.441	4.136	0.252	0.993	0.757
420	3.40	1.759	0.397	3.916	0.226	1.038	0.759
480	3.74	1.764	0.462	4.279	0.263	0.975	0.761
540	4.41	1.754	0.480	4.370	0.274	0.954	0.757
600	5.09	1.744	0.490	4.422	0.282	0.942	0.753
720	6.11	1.720	0.499	4.434	0.291	0.927	0.743
840	6.79	1.711	0.506	4.464	0.296	0.917	0.738
960	7.47	1.701	0.507	4.449	0.299	0.914	0.734
1080	8.83	1.663	0.508	4.381	0.306	0.904	0.718
1200	10.19	1.633	0.514	4.362	0.315	0.890	0.705
1320	11.54	1.694	0.492	4.333	0.291	0.927	0.731
1440	13.24	1.624	0.477	4.107	0.294	0.925	0.701
1560	14.60	1.573	0.487	4.068	0.310	0.902	0.679
1588	15.00	1.557	0.485	4.022	0.312	0.901	0.672

W.O. No. ch92195w1
Req. No. CENCS-IA-93-30-ED-GH
Contract No.



	% COBBLES	% GRAVEL	% SAND	% SILT OR CLAY	
●	0.0	0.0	0.4	32.0	67.6

	Sample No.	Elev or Depth	Nat W%	LL	PL	PI	C_c	C_u
●	W-1	2.0'-4.0'		67	57	10		

CLASSIFICATION

● ELASTIC SILT, MH
Specific Gravity = 2.63

Remarks:	Project CHASKA FLOOD CONTROL EAST CREEK, STAGE 3 Lab No. 1897 Area Boring No. 92-195 MU1 Date 02/04/93

GRADATION CURVES

CORPS OF ENGINEERS, MISSOURI RIVER DIVISION LAB
420 SOUTH 18th STREET - OMAHA, NE 68102-2586

Figure 4 FIG D-305

CLASSIFICATION TEST REQUEST

PROJECT: Chaska Flood C.P.

MRD LAB. NO.: 1897

ACCOMPANYING TEST: $\bar{R}$, Q

REQUEST NO.: CENCS-ZA-93-

CONTAINER - TYPE:

NO.: - 30-ED-GH

SAMPLE IDENTIFICATION:

92-195 MU W-1 2-4

SAMPLE IDENTIFICATION:

Structure: (X) Brittle (X) Plastic ( )

Consistency: Undisturbed (/) Soft (/) Med ( ) Stiff ( ) Hard

Remolded ( ) Insensitive (/) Sl. Sens. ( ) Sensitive

PL Thread: Strength (/) Low ( ) Med ( ) High ( )

Shine (X) None ( ) Dull ( ) Gloss ( ) H. Gloss ( )

Shake Test (X) None (X) Slow ( ) Fast ( ) Rapid ( )

Torvane: 0.30

Odor: slight

Color: White grey & lt Gray

Cementation: Slight

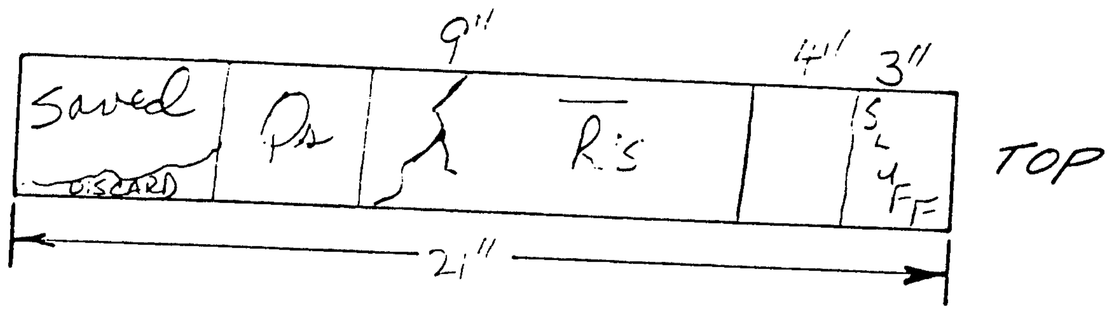
Disturbance: none

Date Core Opened: 2-1-93

Est. Max. Particle Size: +50

Sketch: (Core description and specimen location)

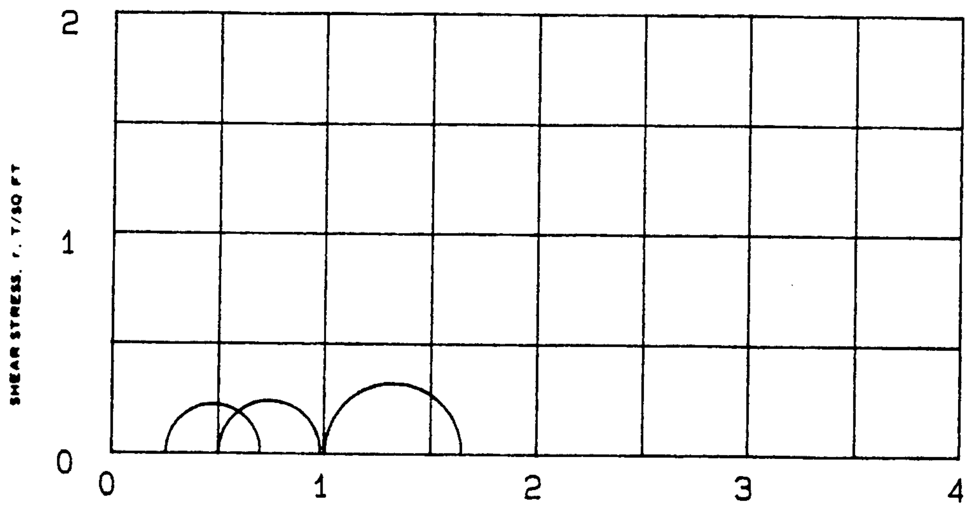
Remarks: sample has rootlets & whst app coloration throughout

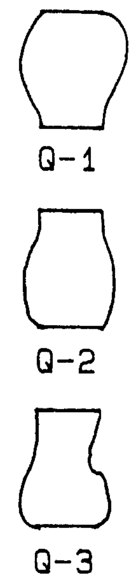


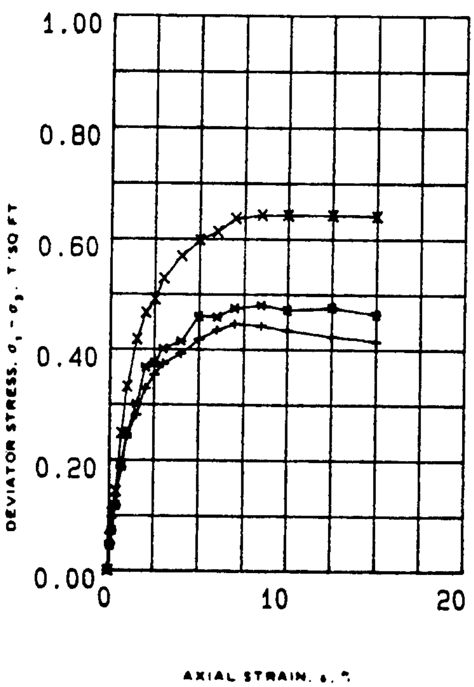
Technician CW Black

Figure 5

FIGURE D-306







SPECIMEN NO.			1 (+)	2 (*)	3 (X)	
INITIAL	WATER CONTENT, %	w_o	106.2	107.5	106.1	
	DRY DENSITY LB/CU FT	γd_o	41.4	40.9	42.1	
	SATURATION, %	S_o	95.0	94.0	97.0	
	VOID RATIO	e_o	2.92	2.97	2.85	
BEFORE SHEAR	WATER CONTENT, %	w_c	105.8	106.1	104.6	
	DRY DENSITY LB/CU FT	γd_c	41.3	40.9	42.3	
	SATURATION, %	S_c	94.0	93.0	96.0	
	VOID RATIO	e_c	2.93	2.97	2.84	
	FINAL BACK PRESSURE, T/SQ FT	u_o	0.0	0.0	0.0	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	0.3	0.5	1.0	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	0.45	0.48	0.64	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	14.0	17.3	20.0	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	0.41	0.46	0.64	
INITIAL DIAMETER, IN		D_o	1.41	1.40	1.40	
INITIAL HEIGHT, IN		H_o	2.97	2.98	2.97	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Elastic Silt, MH

LL 90	PL 60	PI 30	G_s 2.6	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST Q

REMARKS Light gray and white gray. Torvane = 0.29 TSF. Slightly calcareous.

PROJECT CHASKA FLOOD; IA-93-30

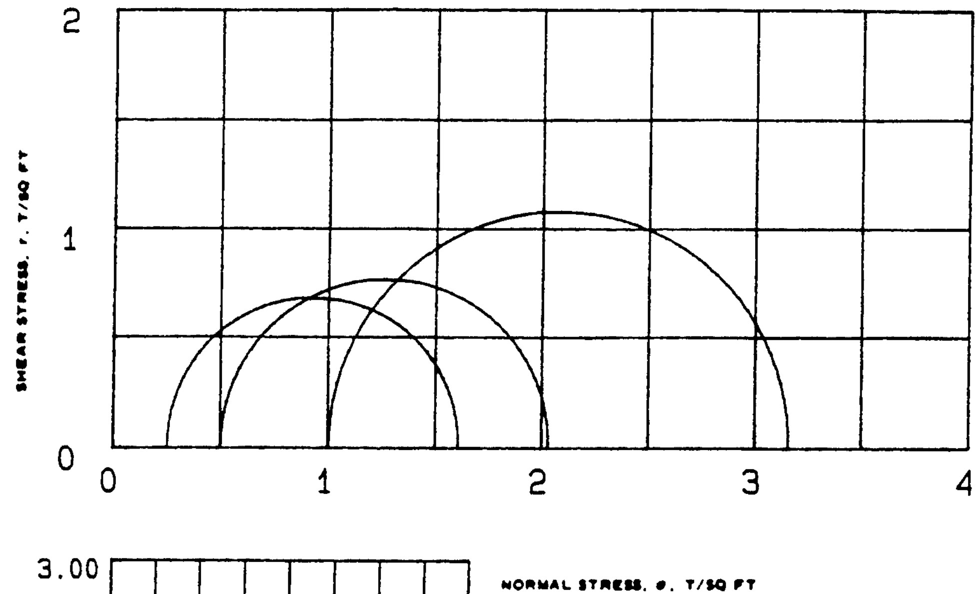
BORING NO 92-195 MU — SAMPLE NO. W-2

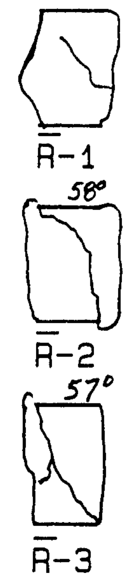
DEPTH ELEV 11'-13'

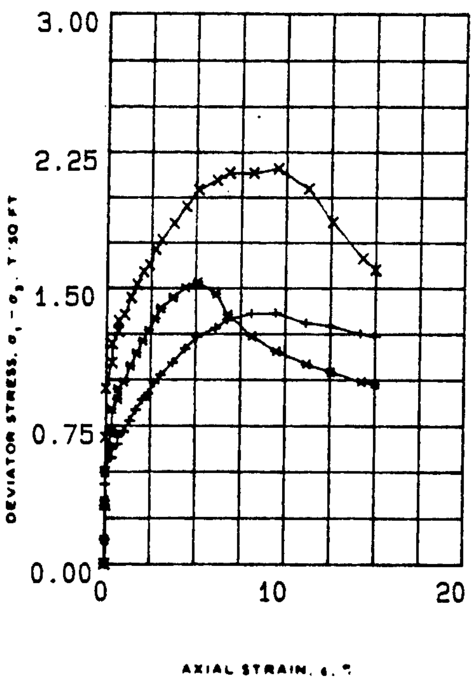
LABORATORY 1897 — DATE 2-13-93

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO 2089 REV JUNE 1970 — PREVIOUS EDITION IS OBSOLETE — TRANSLUCENT — (EM 1110-2-1906) — FIGURE 6







SPECIMEN NO.			1 (+)	2 (*)	3 (X)
INITIAL	WATER CONTENT, %	w_0	98.5	95	98.2
	DRY DENSITY LB/CU FT	γ_{d_0}	45.4	45.8	45.5
	SATURATION, %	S_0	99	97	100
	VOID RATIO	e_0	2.58	2.55	2.57
BEFORE SHEAR	WATER CONTENT, %	w_c	97.1	94.3	97.5
	DRY DENSITY LB/CU FT	γ_{d_c}	46.4	47.4	47.2
	SATURATION, %	S_c	100	100	100
	VOID RATIO	e_c	2.5	2.43	2.44
	FINAL BACK PRESSURE, T/SQ FT	u_0	3.383	3.383	3.383
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.25	.5	1
MAXIMUM DEVIATOR STRESS T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	1.360	1.531	2.158
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	1200	720	1200
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	1.235	0.976	1.598
INITIAL DIAMETER, IN.		D_0	1.41	1.42	1.41
INITIAL HEIGHT, IN.		H_0	2.99	2.98	2.98
B-Value			1.0	1.0	1.0

CONTROLLED- STRAIN TEST

Description of Specimens: Elastic Silt, MH

LL 90	PL 60	PI 30	G_s 2.6	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST RBAR

REMARKS Light gray and white gray. Torvane = 0.29 TSF. Slightly calcareous.

PROJECT CHASKA FLOOD C.P.; IA-93-30

BORING NO 92-195 MU

SAMPLE NO. W-2

DEPTH ELEV 11.0'-13.0'

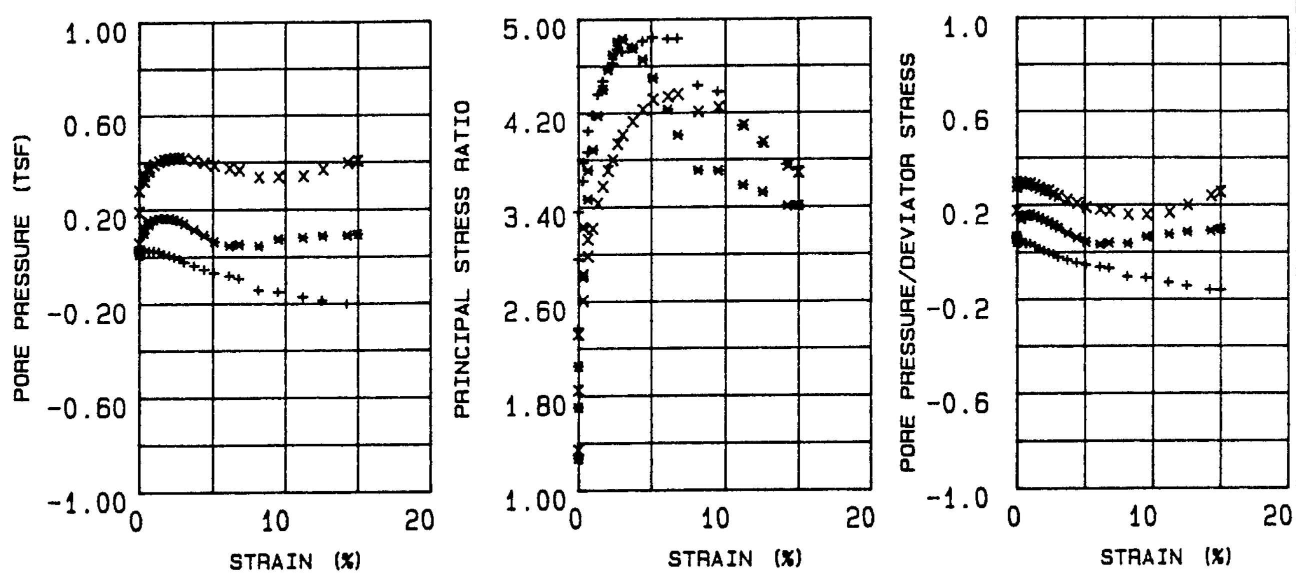
LABORATORY 1897

DATE 2-4-1993

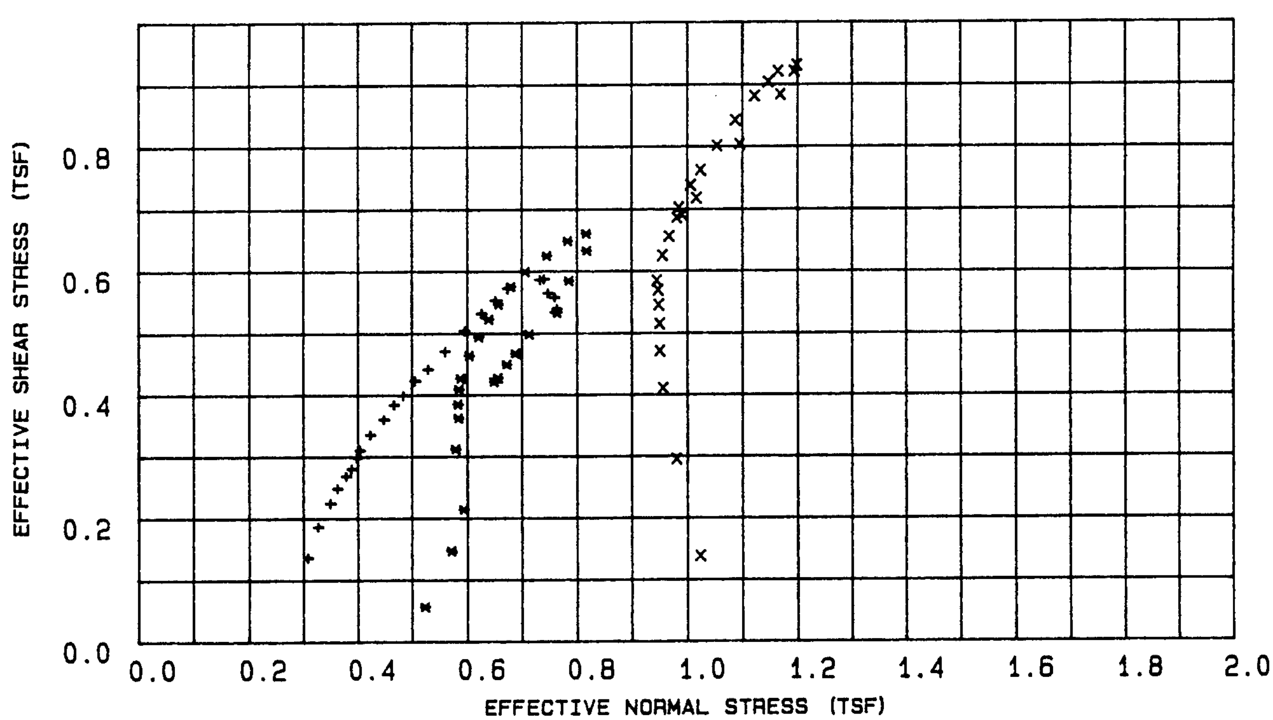
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

FIGURE 7



EFFECTIVE STRESS VECTOR CURVES ON 60 DEGREE PLANE



LEGEND

+ = .25 TSF
* = .5 TSF
X = 1 TSF

PROJECT	CHASKA FLOOD C.P.: IA-93-30
BORING NO.	92-195 MU
SAMPLE NO.	W-2
DEPTH/ELEV	11.0'-13.0'
MRD LAB NO.	1897

FIGURE 8

FIGURE D-309

Table 4 - Triaxial $\bar{R}$ Test Results

Project : CHASKA FLOOD C.P.;IA-93-30
Boring Number : 92-195 MU
Sample Number : W-2
Depth : 11.0'-13.0'
Confining Pressure : .25 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.00	0.315	0.020	2.369	0.065	0.308	0.136
30	0.00	0.431	0.030	2.956	0.069	0.327	0.186
45	0.00	0.520	0.030	3.358	0.057	0.349	0.224
60	0.34	0.575	0.030	3.618	0.053	0.362	0.248
90	0.34	0.622	0.026	3.775	0.042	0.378	0.268
120	0.68	0.649	0.023	3.861	0.036	0.388	0.280
150	0.68	0.691	0.023	4.044	0.034	0.398	0.298
180	1.01	0.718	0.024	4.183	0.035	0.404	0.310
210	1.35	0.777	0.019	4.359	0.025	0.423	0.335
240	1.69	0.835	0.009	4.471	0.012	0.448	0.360
300	2.03	0.889	0.003	4.596	0.004	0.467	0.384
360	2.36	0.924	-0.005	4.621	-0.005	0.484	0.399
420	2.70	0.981	-0.012	4.741	-0.012	0.505	0.423
480	3.04	1.024	-0.025	4.722	-0.024	0.529	0.442
540	3.71	1.092	-0.040	4.761	-0.036	0.560	0.471
600	4.39	1.167	-0.056	4.813	-0.048	0.595	0.504
720	5.06	1.233	-0.071	4.845	-0.057	0.626	0.532
840	6.08	1.280	-0.084	4.830	-0.065	0.651	0.553
960	6.75	1.326	-0.096	4.834	-0.072	0.674	0.572
1080	8.10	1.358	-0.146	4.429	-0.107	0.732	0.586
1200	9.45	1.360	-0.153	4.377	-0.112	0.740	0.587
1320	11.14	1.306	-0.174	4.084	-0.132	0.747	0.564
1440	12.49	1.290	-0.190	3.932	-0.147	0.759	0.557
1560	14.18	1.249	-0.204	3.749	-0.163	0.763	0.539
1618	15.00	1.235	-0.204	3.722	-0.164	0.759	0.533

Table 5 - Triaxial $\bar{R}$ Test Results

Project : CHASKA FLOOD C.P.;IA-93-30
Boring Number : 92-195 MU
Sample Number : W-2
Depth : 11.0'-13.0'
Confining Pressure : .5 TSF

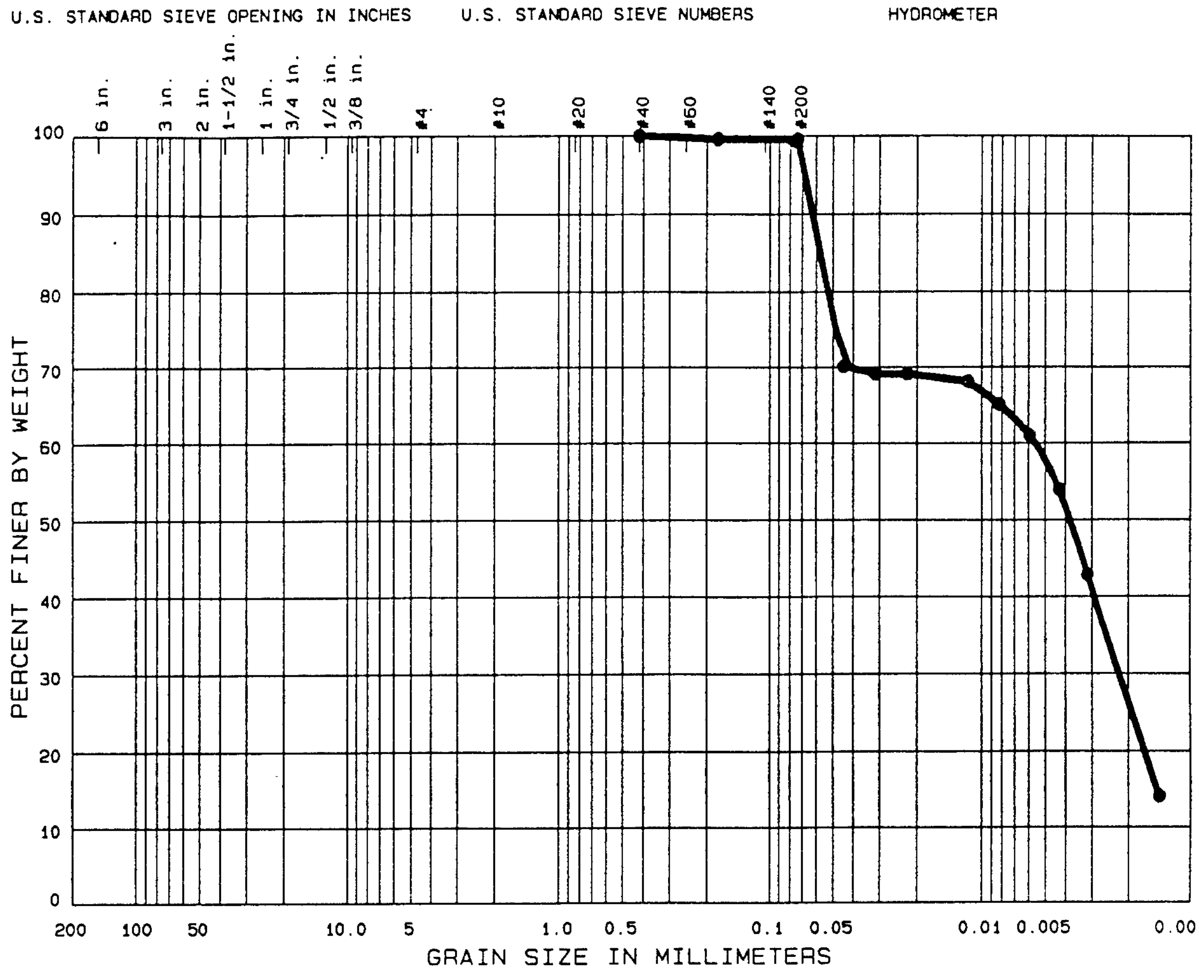
Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.00	0.131	0.009	1.266	0.067	0.523	0.056
30	0.00	0.341	0.013	1.700	0.039	0.571	0.147
45	0.00	0.495	0.028	2.048	0.057	0.594	0.214
60	0.34	0.722	0.100	2.807	0.139	0.579	0.312
90	0.34	0.839	0.124	3.230	0.148	0.584	0.362
120	0.68	0.893	0.138	3.464	0.154	0.583	0.385
150	0.68	0.949	0.150	3.708	0.158	0.585	0.409
180	1.02	0.988	0.157	3.882	0.159	0.588	0.427
210	1.36	1.074	0.162	4.177	0.151	0.604	0.464
240	1.70	1.145	0.163	4.403	0.143	0.621	0.494
300	2.04	1.211	0.161	4.569	0.133	0.639	0.523
360	2.37	1.268	0.157	4.696	0.124	0.657	0.547
420	2.71	1.333	0.150	4.806	0.113	0.680	0.575
480	3.05	1.388	0.138	4.830	0.100	0.706	0.599
540	3.73	1.449	0.114	4.751	0.079	0.745	0.625
600	4.41	1.504	0.089	4.655	0.059	0.783	0.649
720	5.09	1.531	0.062	4.495	0.041	0.817	0.661
840	6.11	1.466	0.045	4.224	0.031	0.818	0.633
960	6.78	1.353	0.050	4.005	0.037	0.785	0.584
1080	8.14	1.235	0.043	3.704	0.035	0.763	0.533
1200	9.50	1.153	0.073	3.699	0.064	0.713	0.498
1320	11.19	1.083	0.080	3.577	0.074	0.688	0.467
1440	12.55	1.041	0.086	3.517	0.084	0.672	0.449
1560	14.25	0.988	0.089	3.403	0.090	0.656	0.427
1613	15.00	0.976	0.094	3.404	0.097	0.648	0.421

Table 6 - Triaxial $\bar{R}$ Test Results

Project : CHASKA FLOOD C.P.;IA-93-30
Boring Number : 92-195 MU
Sample Number : W-2
Depth : 11.0'-13.0'
Confining Pressure : 1 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.00	0.320	0.056	1.339	0.176	1.023	0.138
30	0.00	0.685	0.189	1.845	0.277	0.980	0.295
45	0.00	0.950	0.279	2.318	0.295	0.956	0.410
60	0.34	1.090	0.320	2.604	0.294	0.950	0.471
90	0.34	1.194	0.346	2.825	0.290	0.950	0.515
120	0.68	1.262	0.364	2.983	0.289	0.948	0.545
150	0.68	1.319	0.379	3.125	0.288	0.947	0.569
180	1.02	1.353	0.390	3.217	0.288	0.945	0.584
210	1.36	1.448	0.404	3.429	0.279	0.955	0.625
240	1.70	1.519	0.409	3.570	0.270	0.967	0.656
300	2.04	1.590	0.413	3.706	0.260	0.981	0.686
360	2.38	1.627	0.418	3.797	0.258	0.985	0.702
420	2.72	1.711	0.417	3.933	0.244	1.006	0.738
480	3.06	1.766	0.413	4.009	0.235	1.024	0.762
540	3.74	1.856	0.406	4.126	0.219	1.054	0.801
600	4.42	1.950	0.396	4.228	0.204	1.087	0.842
720	5.10	2.042	0.384	4.314	0.188	1.122	0.881
840	6.12	2.095	0.372	4.337	0.178	1.147	0.904
960	6.81	2.135	0.364	4.358	0.171	1.165	0.921
1080	8.17	2.134	0.334	4.205	0.157	1.194	0.921
1200	9.53	2.158	0.335	4.244	0.156	1.199	0.931
1320	11.23	2.046	0.338	4.089	0.166	1.169	0.883
1440	12.59	1.860	0.367	3.940	0.198	1.094	0.803
1560	14.29	1.661	0.395	3.743	0.238	1.016	0.717
1610	15.00	1.598	0.404	3.683	0.254	0.991	0.690

W.O. No.
Req. No. CENCS-IA-93-30-ED-GH
Contract No.



% COBBLES		% GRAVEL	% SAND	% SILT OR CLAY	
●	0.0	0.0	0.4	41.7	57.9

	Sample No.	Elev or Depth	Nat W%	LL	PL	PI	C_c	C_u
●	W-2	11.0'-13.0'		90	60	30		

CLASSIFICATION

● ELASTIC SILT, MH

Remarks:

Project CHASKA FLOOD CONTROL

Lab No. 1897

Area

Boring No. 92-195MU Date 2-18-93

GRADATION CURVES

CORPS OF ENGINEERS, MISSOURI RIVER DIVISION LAB
420 SOUTH 18th STREET - OMAHA, NE 68102-2586

Figure 9FIG D-31

CLASSIFICATION TEST REQUEST

PROJECT: Chaska Flood C.P. MRD LAB. NO.:

ACCOMPANYING TEST: R, Q REQUEST NO.:

CONTAINER - TYPE: 5" shelby NO.: -

SAMPLE IDENTIFICATION:
92-195mu W-2 11-13

SAMPLE IDENTIFICATION:

Structure: ( ) Brittle (X) Plastic ( )

Consistency: Undisturbed (X) Soft ( ) Med ( ) Stiff ( ) Hard

Remolded ( ) Insensitive (X) Sl. Sens. ( ) Sensitive

PL Thread: Strength (X) Low ( ) Med ( ) High ( )

Shine (X) None (X) Dull ( ) Gloss ( ) H. Gloss ( )

Shake Test ( ) None (X) Slow (X) Fast ( ) Rapid ( )

Torvane: 0.29

Color: Lt grey & white grey

Disturbance: none

Est. Max. Particle Size: +50

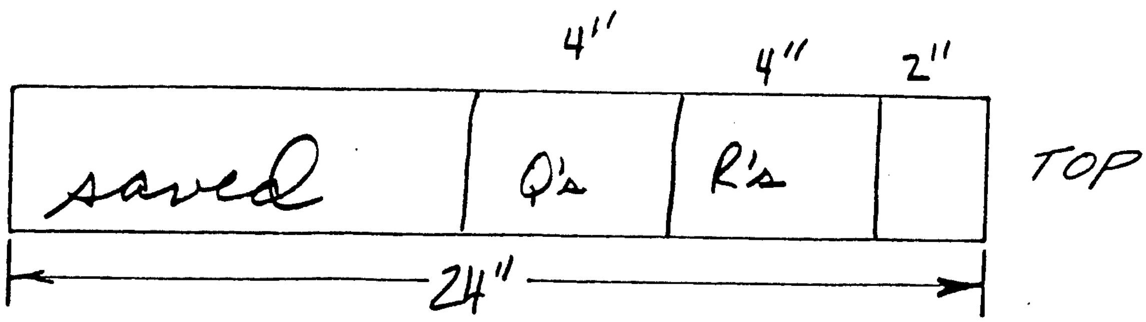
Remarks: calcium & wood chips throughout sample

Odor: slight

Cementation: slight

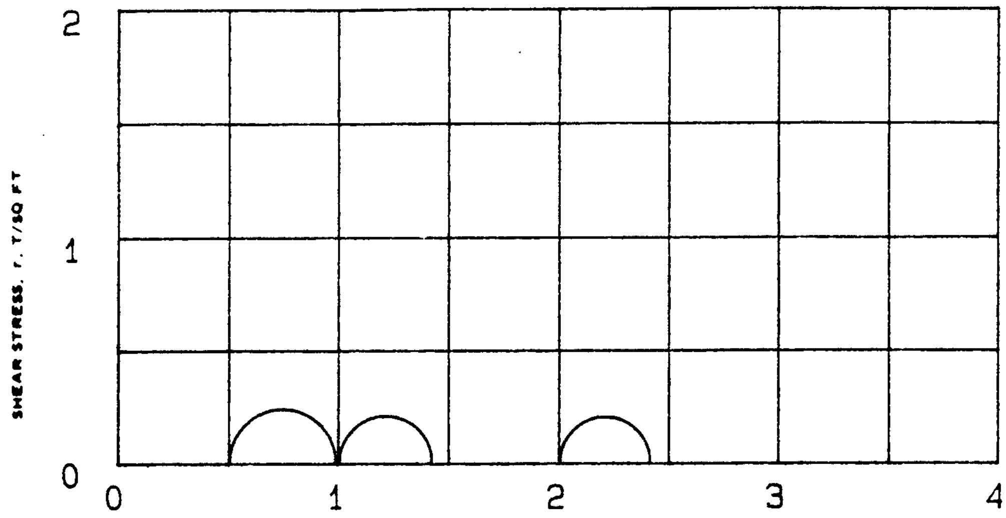
Date Core Opened: 2-4-93

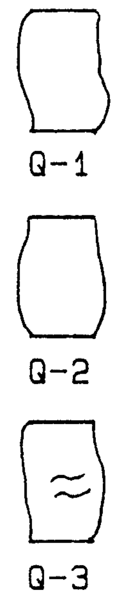
Sketch: (Core description and specimen location)

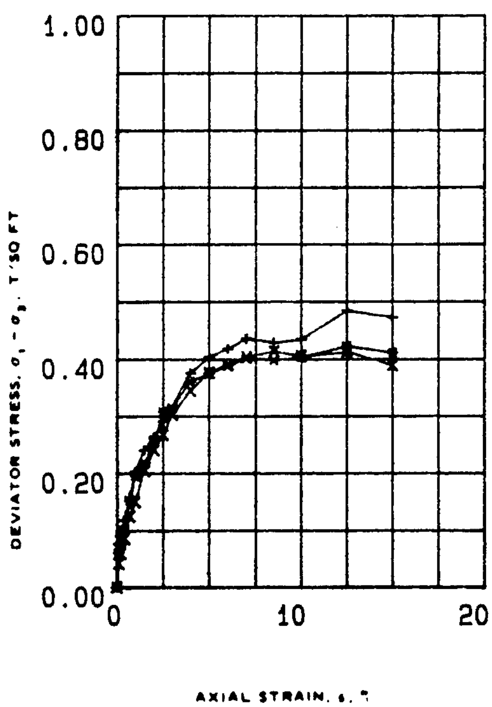


Technician CW Black

Figure 10
FIGURE D-314







			1 (+)	2 (*)	3 (X)
SPECIMEN NO.			1 (+)	2 (*)	3 (X)
INITIAL	WATER CONTENT, %	w_o	108.0	109.8	110.5
INITIAL	DRY DENSITY LB/CU FT	γ_{d_o}	42.6	41.7	41.5
INITIAL	SATURATION, %	S_o	100.0	99.0	99.0
INITIAL	VOID RATIO	e_o	2.81	2.90	2.91
BEFORE SHEAR	WATER CONTENT, %	w_c	106.6	108.2	109.7
BEFORE SHEAR	DRY DENSITY LB/CU FT	γ_{d_c}	42.5	41.6	41.4
BEFORE SHEAR	SATURATION, %	S_c	98.0	97.0	98.0
BEFORE SHEAR	VOID RATIO	e_c	2.82	2.90	2.92
BEFORE SHEAR	FINAL BACK PRESSURE, T/SQ FT	u_o	0.0	0.0	0.0
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	0.5	1.0	2.0
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	0.48	0.42	0.41
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	25.5	25.0	16.0
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	0.47	0.41	0.39
INITIAL DIAMETER, IN.		D_o	1.37	1.40	1.40
INITIAL HEIGHT, IN.		H_o	2.99	2.98	3.01

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Elastic silt, MH

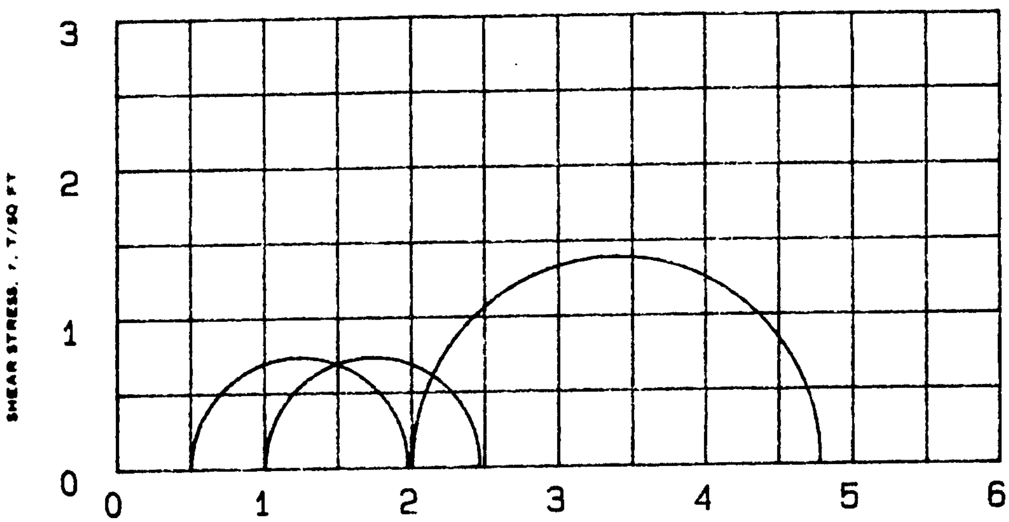
LL 69	PL 61	PI 8	G_s 2.6	TYPE OF SPECIMEN	UNDISTURBED	TYPE OF TEST	Q

REMARKS: Gray. Torvane = 0.30 TSF. Calcareous.

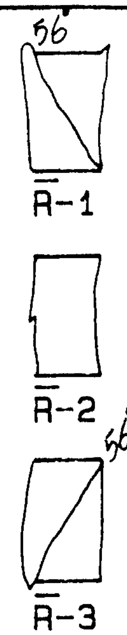
PROJECT	CHASKA FLOOD CONTROL; CENCS-IA-93-30-ED-6
BORING NO	92-195MU
SAMPLE NO.	W-3
DEPTH ELEV	15.0'-17.0'
LABORATORY	1897
DATE	2/9/93

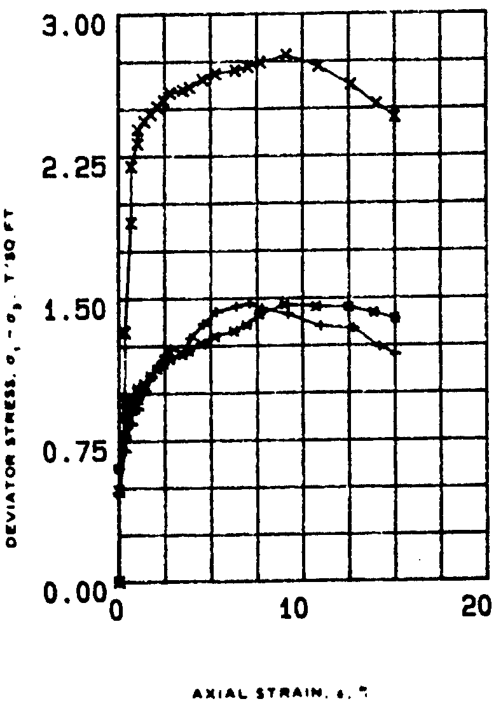
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT *(EM 1110-2-1906)* FIGURE 11



NORMAL STRESS, σ, T/SQ FT





			1 (+)	2 (*)	3 (X)	
SPECIMEN NO.			1 (+)	2 (*)	3 (X)	
INITIAL	WATER CONTENT, %	w_o	107.1	112.9	115.4	
	DRY DENSITY LB/CU FT	γ_{d_o}	42.8	40.4	40.4	
	SATURATION, %	S_o	100	97	99	
	VOID RATIO	e_o	2.79	3.01	3.02	
BEFORE SHEAR	WATER CONTENT, %	w_c	98.3	102.3	96.9	
	DRY DENSITY LB/CU FT	γ_{d_c}	49.6	44.1	45.8	
	SATURATION, %	S_c	100	99	99	
	VOID RATIO	e_c	2.27	2.68	2.55	
	FINAL BACK PRESSURE, T/SQ FT	u_o	4.823	4.823	4.823	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.5	1	2	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	1.471	1.486	2.780	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	840	1080	1080	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	1.199	1.389	2.451	
INITIAL DIAMETER, IN.		D_o	1.4	1.41	1.4	
INITIAL HEIGHT, IN.		H_o	2.97	2.97	2.97	
B-Value			1.0	1.0	1.0	

CONTROLLED- STRAIN TEST

Description of Specimens: Elastic Silt, MH

LL 69	PL 61	PI 8	Gs 2.8

TYPE OF SPECIMEN UNDISTURBED | TYPE OF TEST RBAR

REMARKS: Gray. Torvane = 0.30 TSF.
Calcareous.

PROJECT CHASKA FLOOD; CENCS-IA-93-30-ED-GH

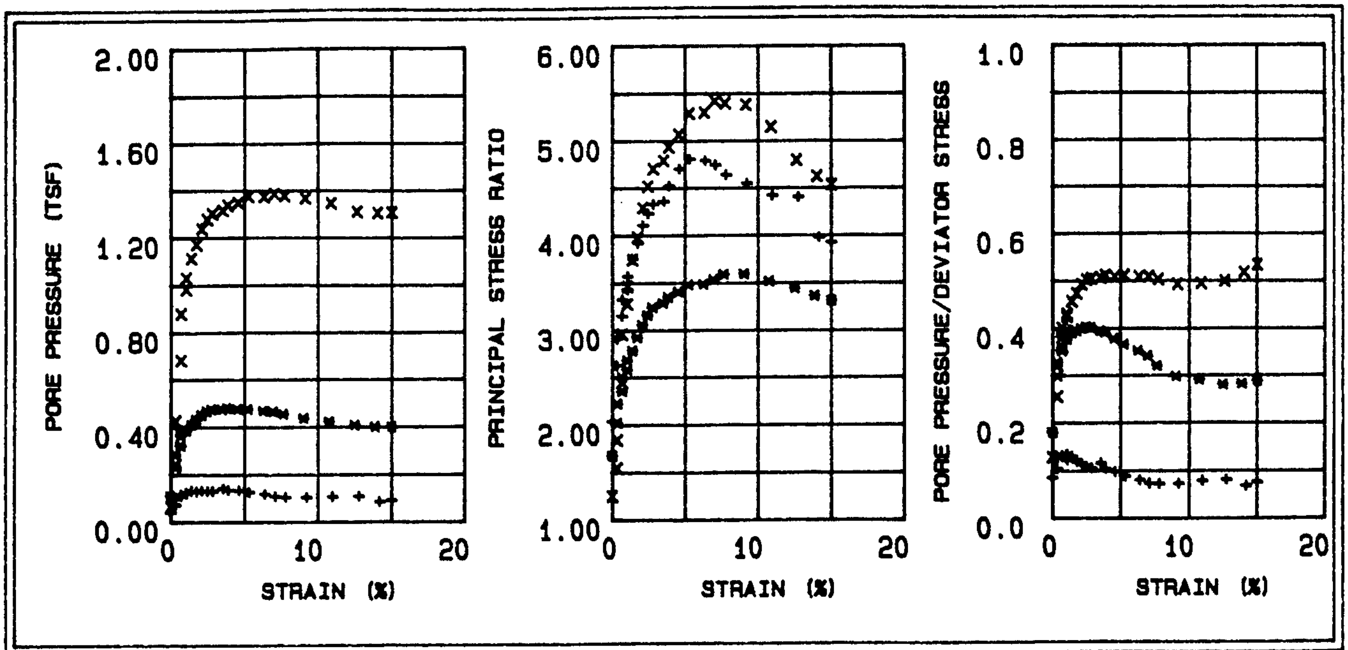
BORING NO 92-195MU | SAMPLE NO. W-3

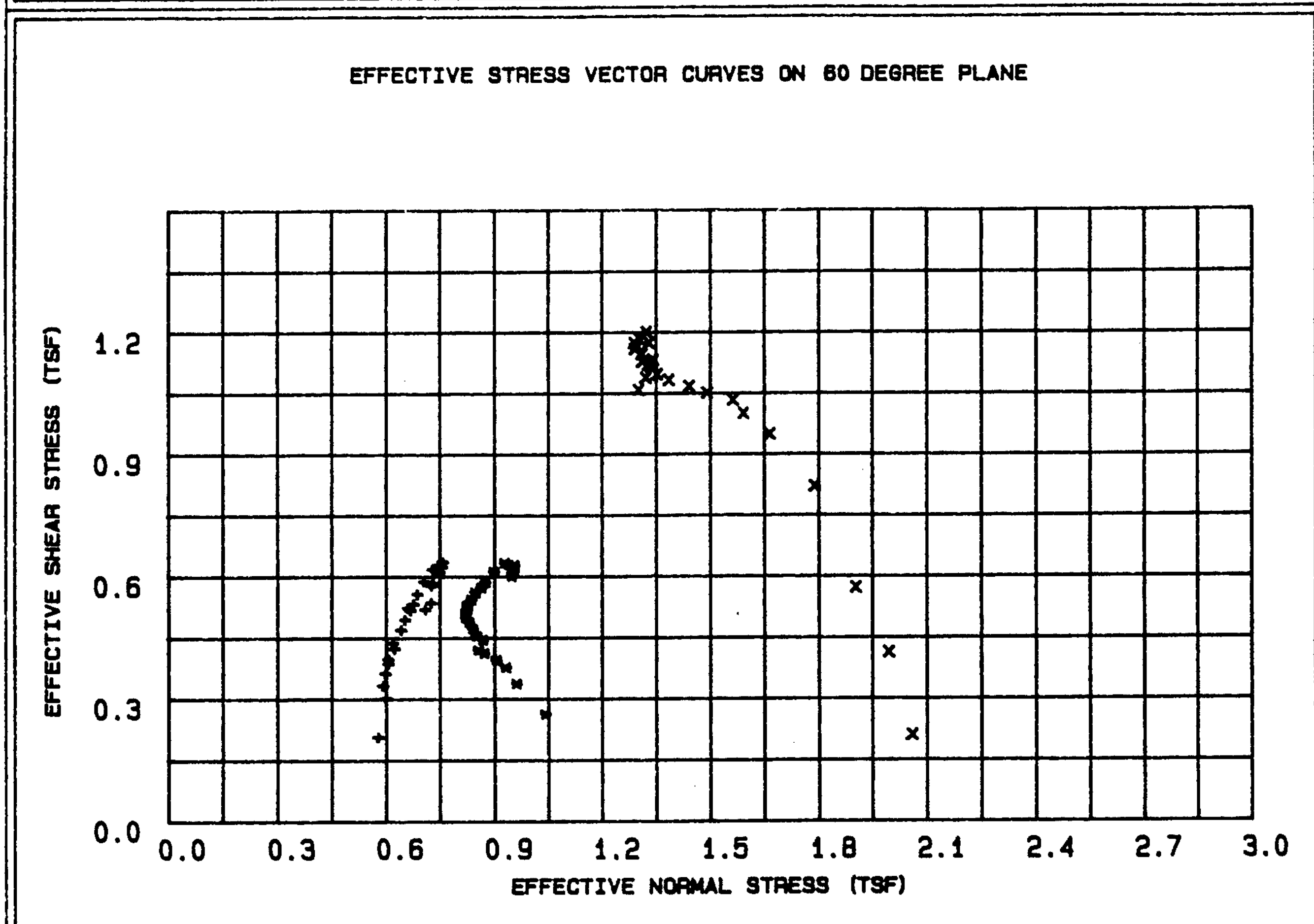
DEPTH ELEV 15.0'-17.0'

LABORATORY 1897 | DATE 3-11-93

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906) FIGURE 12





LEGEND

+ = .5 TSF
✱ = 1 TSF
X = 2 TSF

PROJECT	CHASKA FLOOD; CENCS-IA-93-30-ED-GH
BORING NO.	92-195MU
SAMPLE NO.	W-3
DEPTH/ELEV	15.0'-17.0'
MRD LAB NO.	1897

FIGURE 13

Table 7 - Triaxial $\bar{R}$ Test Results

Project : CHASKA FLOOD; CENCS-IA-93-30-ED-GH
Boring Number : 92-195MU
Sample Number : W-3
Depth : 15.0'-17.0'
Confining Pressure : .5 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.00	0.476	0.040	2.036	0.085	0.578	0.206
30	0.35	0.697	0.072	2.628	0.104	0.600	0.301
45	0.35	0.768	0.099	2.914	0.129	0.591	0.332
60	0.71	0.839	0.110	3.152	0.132	0.598	0.362
90	0.71	0.895	0.115	3.326	0.129	0.607	0.386
120	1.06	0.919	0.122	3.434	0.134	0.606	0.397
150	1.06	0.980	0.119	3.571	0.122	0.624	0.423
180	1.42	1.014	0.132	3.753	0.130	0.619	0.437
210	1.77	1.087	0.127	3.919	0.118	0.642	0.469
240	2.12	1.145	0.131	4.105	0.115	0.653	0.494
300	2.48	1.198	0.129	4.229	0.108	0.668	0.517
360	2.83	1.235	0.129	4.329	0.105	0.677	0.533
420	3.54	1.210	0.140	4.358	0.116	0.660	0.522
480	3.89	1.291	0.133	4.520	0.104	0.687	0.557
540	4.60	1.363	0.132	4.701	0.097	0.705	0.588
600	5.31	1.429	0.125	4.806	0.088	0.729	0.617
720	6.37	1.456	0.116	4.790	0.080	0.744	0.628
840	7.08	1.471	0.107	4.740	0.073	0.757	0.635
960	7.79	1.444	0.103	4.637	0.072	0.754	0.623
1080	9.20	1.413	0.102	4.545	0.072	0.748	0.610
1200	10.97	1.350	0.105	4.418	0.078	0.729	0.583
1320	12.74	1.337	0.107	4.399	0.080	0.724	0.577
1440	14.16	1.240	0.083	3.972	0.067	0.724	0.535
1497	15.00	1.199	0.089	3.919	0.075	0.708	0.518

Table 8 - Triaxial $\bar{R}$ Test Results

Project : CHASKA FLOOD; CENCS-IA-93-30-ED-GH
Boring Number : 92-195MU
Sample Number : W-3
Depth : 15.0'-17.0'
Confining Pressure : 1 TSF

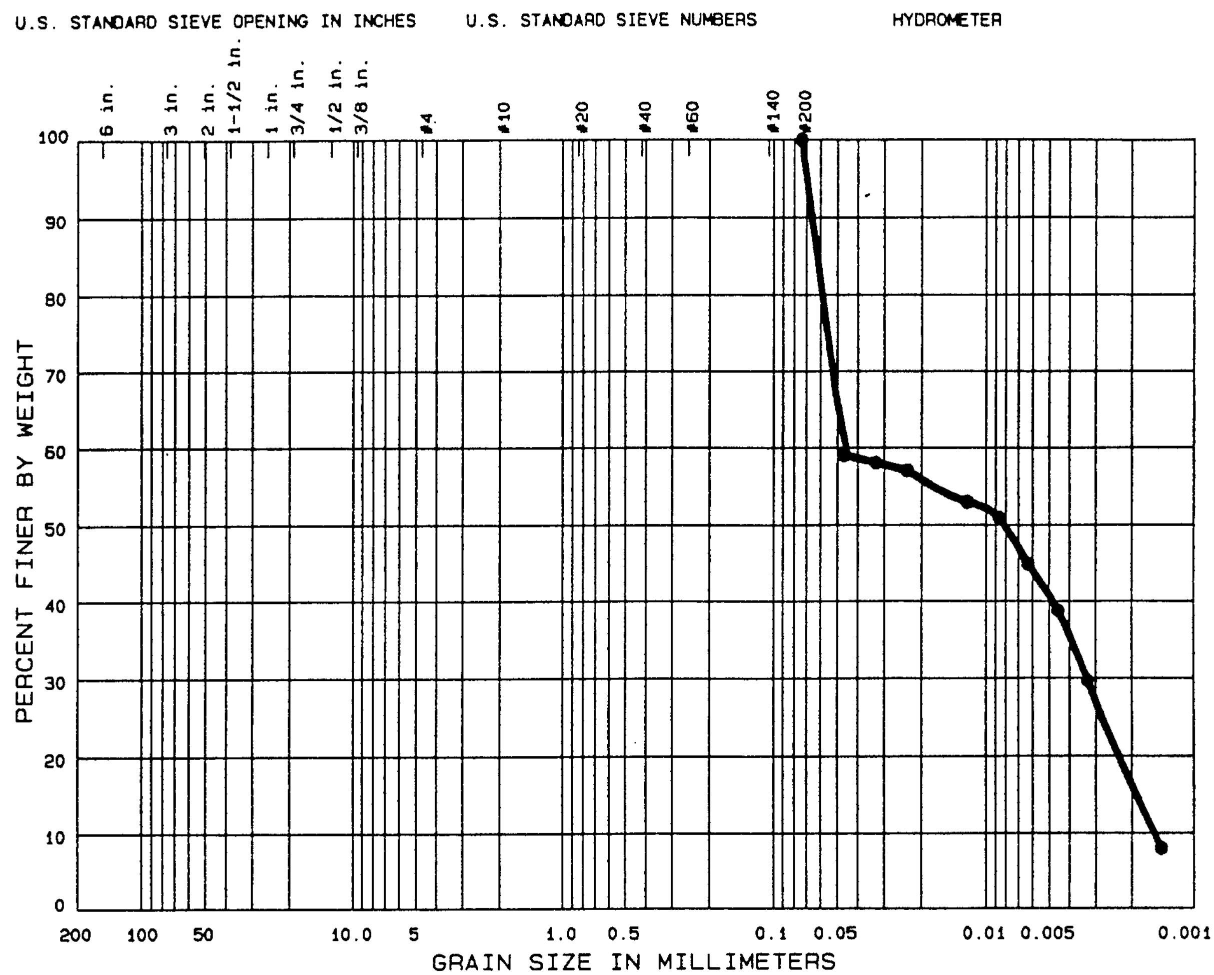
Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.00	0.606	0.109	1.680	0.180	1.041	0.262
30	0.35	0.781	0.233	2.019	0.299	0.960	0.337
45	0.35	0.874	0.286	2.224	0.328	0.930	0.377
60	0.69	0.916	0.323	2.354	0.353	0.904	0.395
90	0.69	0.955	0.365	2.504	0.383	0.871	0.412
120	1.04	0.973	0.386	2.584	0.397	0.855	0.420
150	1.04	1.031	0.388	2.685	0.377	0.867	0.445
180	1.39	1.053	0.411	2.788	0.391	0.850	0.454
210	1.73	1.094	0.432	2.926	0.395	0.839	0.472
240	2.08	1.130	0.451	3.060	0.400	0.829	0.488
300	2.43	1.156	0.466	3.164	0.403	0.820	0.499
360	2.77	1.182	0.473	3.243	0.401	0.820	0.510
420	3.47	1.205	0.474	3.289	0.394	0.824	0.520
480	3.81	1.225	0.479	3.351	0.391	0.824	0.529
540	4.51	1.261	0.476	3.406	0.378	0.836	0.544
600	5.20	1.301	0.475	3.479	0.366	0.847	0.561
720	6.24	1.327	0.466	3.484	0.352	0.863	0.573
840	6.93	1.360	0.463	3.533	0.341	0.874	0.587
960	7.63	1.416	0.453	3.588	0.320	0.898	0.611
1080	9.01	1.466	0.435	3.593	0.297	0.928	0.633
1200	10.75	1.455	0.421	3.514	0.290	0.939	0.628
1320	12.48	1.452	0.405	3.440	0.279	0.955	0.627
1440	13.86	1.420	0.398	3.359	0.281	0.953	0.613
1518	15.00	1.389	0.398	3.308	0.287	0.946	0.600

Table 9 - Triaxial $\overline{R}$ Test Results

Project : CHASKA FLOOD; CENCS-IA-93-30-ED-GH
Boring Number : 92-195MU
Sample Number : W-3
Depth : 15.0'-17.0'
Confining Pressure : 2 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.00	0.487	0.062	1.251	0.128	2.059	0.210
30	0.35	0.957	0.243	1.545	0.255	1.994	0.413
45	0.35	1.325	0.425	1.841	0.321	1.903	0.572
60	0.70	1.901	0.683	2.444	0.360	1.788	0.821
90	0.70	2.198	0.880	2.962	0.401	1.664	0.949
120	1.05	2.317	0.983	3.278	0.425	1.591	1.000
150	1.05	2.392	1.030	3.465	0.431	1.562	1.033
180	1.40	2.435	1.112	3.744	0.457	1.491	1.051
210	1.75	2.473	1.171	3.982	0.474	1.441	1.067
240	2.10	2.510	1.237	4.290	0.493	1.384	1.083
300	2.45	2.542	1.277	4.517	0.503	1.352	1.097
360	2.81	2.584	1.302	4.704	0.505	1.338	1.115
420	3.51	2.597	1.315	4.789	0.507	1.328	1.121
480	3.86	2.613	1.336	4.937	0.512	1.311	1.128
540	4.56	2.654	1.347	5.065	0.508	1.310	1.146
600	5.26	2.685	1.374	5.288	0.512	1.291	1.159
720	6.31	2.701	1.372	5.299	0.508	1.297	1.166
840	7.01	2.721	1.385	5.421	0.509	1.289	1.174
960	7.71	2.744	1.376	5.397	0.502	1.303	1.184
1080	9.12	2.780	1.365	5.379	0.492	1.323	1.200
1200	10.87	2.721	1.344	5.145	0.494	1.330	1.174
1320	12.62	2.622	1.308	4.791	0.499	1.341	1.132
1440	14.03	2.521	1.303	4.619	0.517	1.321	1.088
1506	15.00	2.451	1.306	4.530	0.533	1.301	1.058

W.O. No.
Req. No. CENCS-IA-93-30-ED-GH
Contract No.



	% COBBLES	% GRAVEL	% SAND	% SILT OR CLAY	
●	0.0	0.0	0.0	59.2	40.8

	Sample No.	Elev or Depth	Nat W%	LL	PL	PI	C_c	C_u
●	W-3	15.0'-17.0'		69	61	8	0.15	30.2

CLASSIFICATION

● ELASTIC SILT, MH

Remarks:

Project CHASKA FLOOD CONTROL

Lab No. 1897

Area

Boring No. 92-195MU   Date 2-18-93

GRADATION CURVES

CORPS OF ENGINEERS, MISSOURI RIVER DIVISION LAB
420 SOUTH 18th STREET - OMAHA, NE 68102-2586

Figure 14 FIG D-3

CLASSIFICATION TEST REQUEST

PROJECT: Chaska Flood Control

MRD LAB. NO.: 1897

ACCOMPANYING TEST: Q, R

REQUEST NO. CENCS-IH-93-30 ED-GH

CONTAINER - TYPE: 5" wax

NO.: -

SAMPLE IDENTIFICATION: 92-195MU 11-3 150-170

SAMPLE IDENTIFICATION:

Structure: ( ) Brittle (✓) Plastic ( )

Consistency: Undisturbed ( ) Soft (✓) Med ( ) Stiff ( ) Hard

Remolded ( ) Insensitive ( ) Sl. Sens. (✓) Sensitive

PL Thread: Strength ( ) Low ( ) Med (✓) High ( )

Shine ( ) None ( ) Dull (✓) Gloss ( ) H. Gloss ( )

Shake Test ( ) None (✓) Slow ( ) Fast ( ) Rapid ( )

Torvane: .3 TSF

Color: grey

Disturbance:

Est. Max. Particle Size:

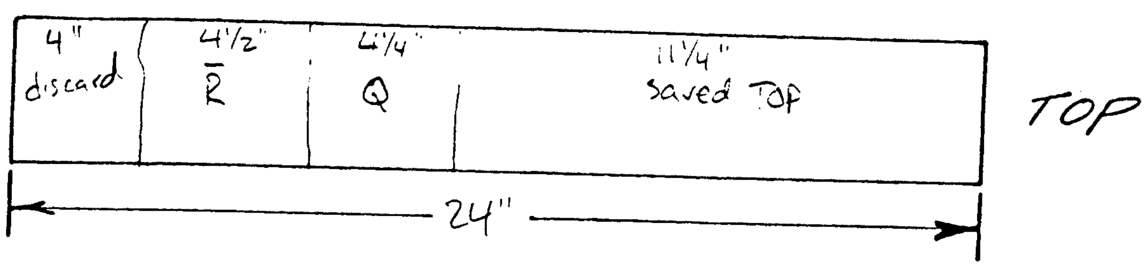
Remarks: water on sample exterior

Odor: river silt

Cementation: reactive to HCl

Date Core Opened: 2/9/93

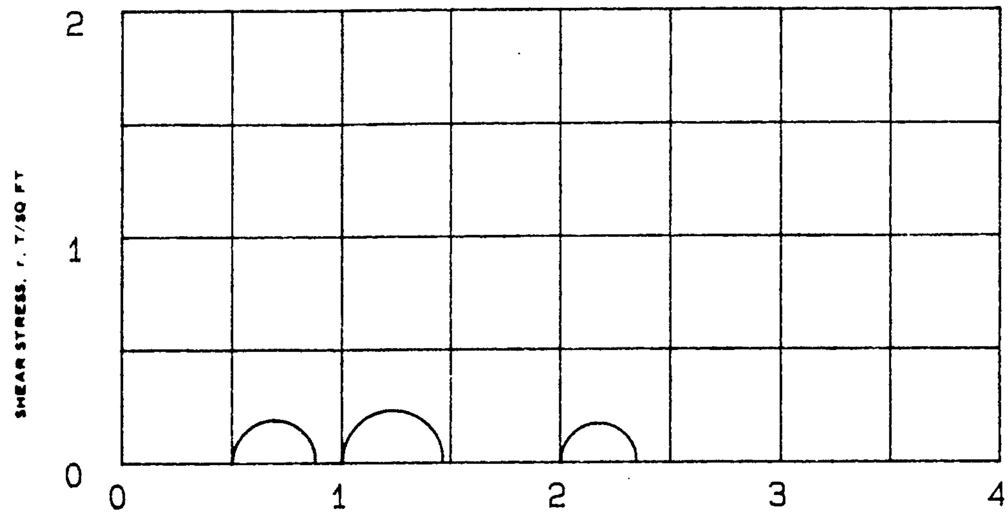
Sketch: (Core description and specimen location)

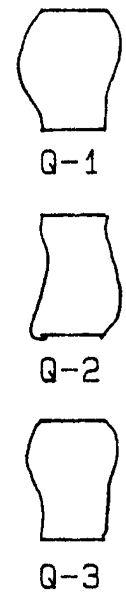


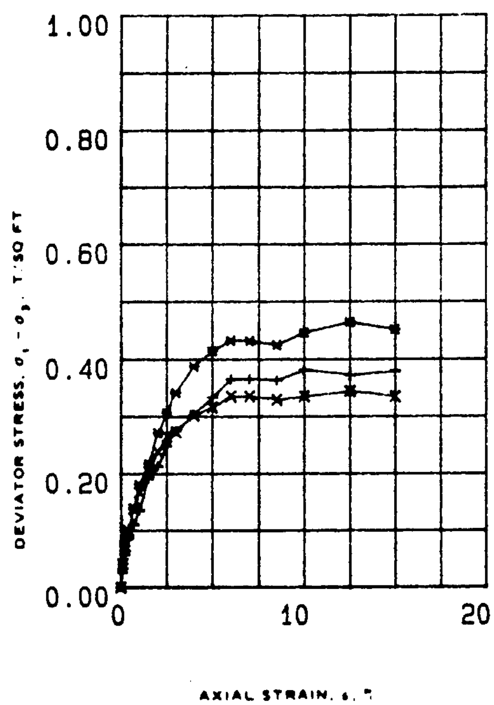
Technician MJW

Figure 15

FIGURE D-322







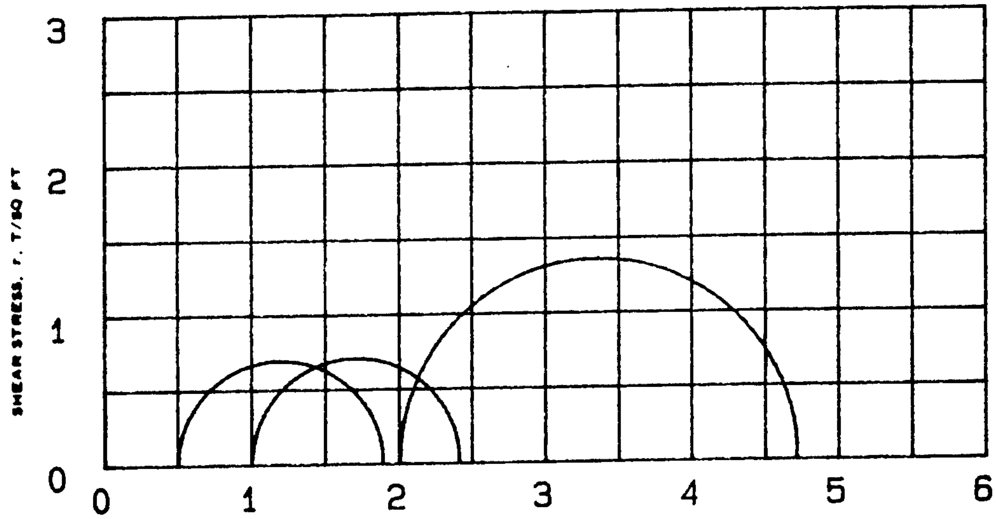
SPECIMEN NO.			1 (+)	2 (✱)	3 (X)
INITIAL	WATER CONTENT, %	w_o	111.4	110.0	113.6
	DRY DENSITY LB/CU FT	γ_{d_o}	41.5	42.0	41.0
	SATURATION, %	S_o	98.0	99.0	99.0
	VOID RATIO	e_o	3.06	3.01	3.11
BEFORE SHEAR	WATER CONTENT, %	w_c	109.9	109.9	113.0
	DRY DENSITY LB/CU FT	γ_{d_c}	41.7	42.1	41.1
	SATURATION, %	S_c	97.0	99.0	98.0
	VOID RATIO	e_c	3.05	3.00	3.10
	FINAL BACK PRESSURE, T/SQ FT	u_o	0.0	0.0	0.0
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	0.5	1.0	2.0
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{MAX}$	0.38	0.46	0.34
TIME TO $(\sigma_1 - \sigma_3)_{MAX}$, MIN		t_f	18.5	23.8	25.3
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ULT}$	0.38	0.45	0.33
INITIAL DIAMETER, IN.		D_o	1.39	1.40	1.40
INITIAL HEIGHT, IN.		H_o	3.00	2.98	2.98

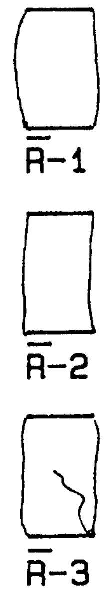
CONTROLLED- STRAIN TEST

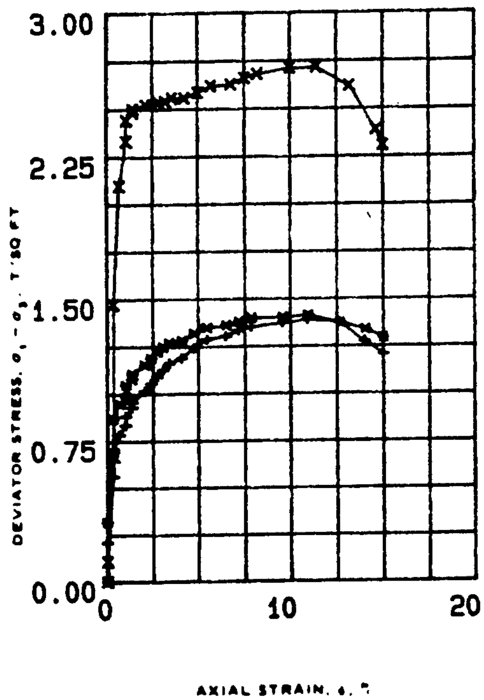
DESCRIPTION OF SPECIMENS Elastic Silt, MH

LL 76	PL 60	PI 16	G_s 2.7	TYPE OF SPECIMEN UNDISTURBED		TYPE OF TEST Q
REMARKS Gray. Torvane = 0.30 TSF.				PROJECT CHASKA FLOOD CONTROL; IA-93-30		
Calcareous.						
				BORING NO 92-195 MU		SAMPLE NO. W-4
				DEPTH ELEV 23.0'-25.0'		
				LABORATORY 1897		DATE 2-10-93
				TRIAXIAL COMPRESSION TEST REPORT		

ENG FORM NO 2089 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906) FIGURE 16
REV JUNE 1970







SPECIMEN NO.			1 (+)	2 (*)	3 (X)
INITIAL	WATER CONTENT, %	w_o	111.9	109	110
	DRY DENSITY LB/CU FT	γd_o	41.7	42.4	42.1
	SATURATION, %	S_o	99	99	99
	VOID RATIO	e_o	3.04	2.97	3
BEFORE SHEAR	WATER CONTENT, %	w_c	99.3	97.7	93.2
	DRY DENSITY LB/CU FT	γd_c	43.2	44.9	49.7
	SATURATION, %	S_c	92	96	100
	VOID RATIO	e_c	2.9	2.76	2.39
	FINAL BACK PRESSURE, T/SQ FT	u_o	4.103	4.103	4.103
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.5	1	2
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{MAX}$	1.387	1.412	2.714
TIME TO $(\sigma_1 - \sigma_3)_{MAX}$, MIN		t_f	1200	1200	1200
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ULT}$	1.204	1.291	2.304
INITIAL DIAMETER, IN.		D_o	1.39	1.4	1.38
INITIAL HEIGHT, IN.		H_o	2.97	2.97	2.96
B-Value			1.0	1.0	1.0

CONTROLLED- STRAIN TEST

Description of Specimens: Elastic Silt, MH

LL 76	PL 60	PI 16	G_s 2.7

REMARKS: Gray. Torvane = 0.30 TSF.

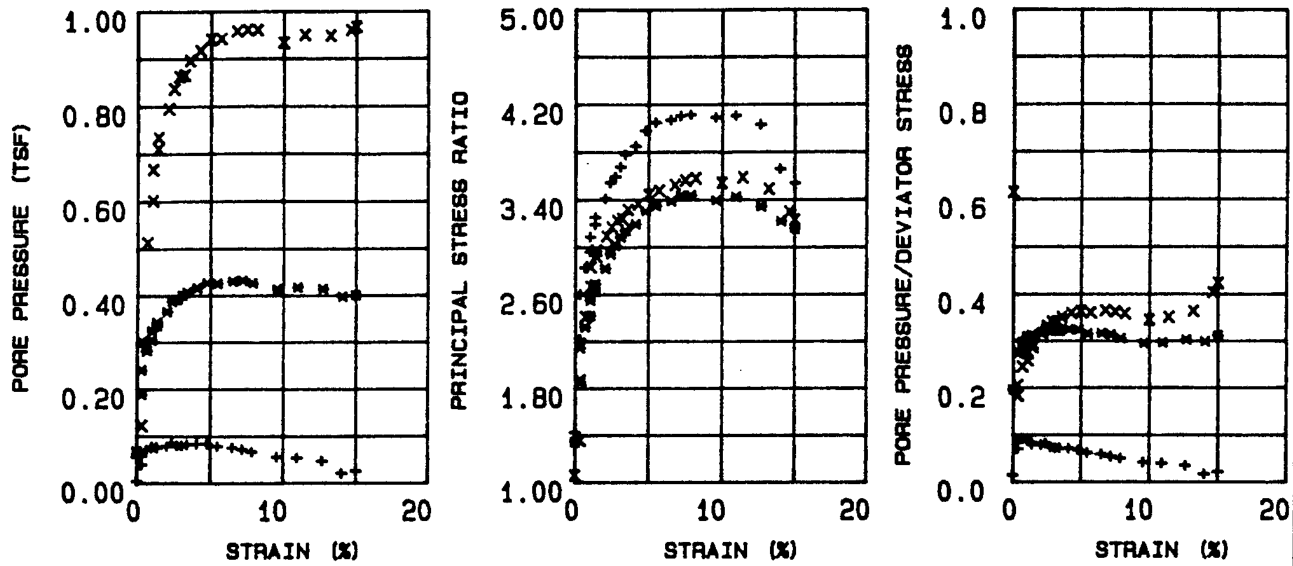
Calcareous. Organic.

TYPE OF SPECIMEN: UNDISTURBED	TYPE OF TEST: RBAR
PROJECT: CHASKA FLOOD; CENCS-IA-93-30-ED-GH	
BORING NO: 92-195MU	SAMPLE NO.: M-4
DEPTH ELEV: 23'-25'	
LABORATORY: 1897	DATE: 2-17-93

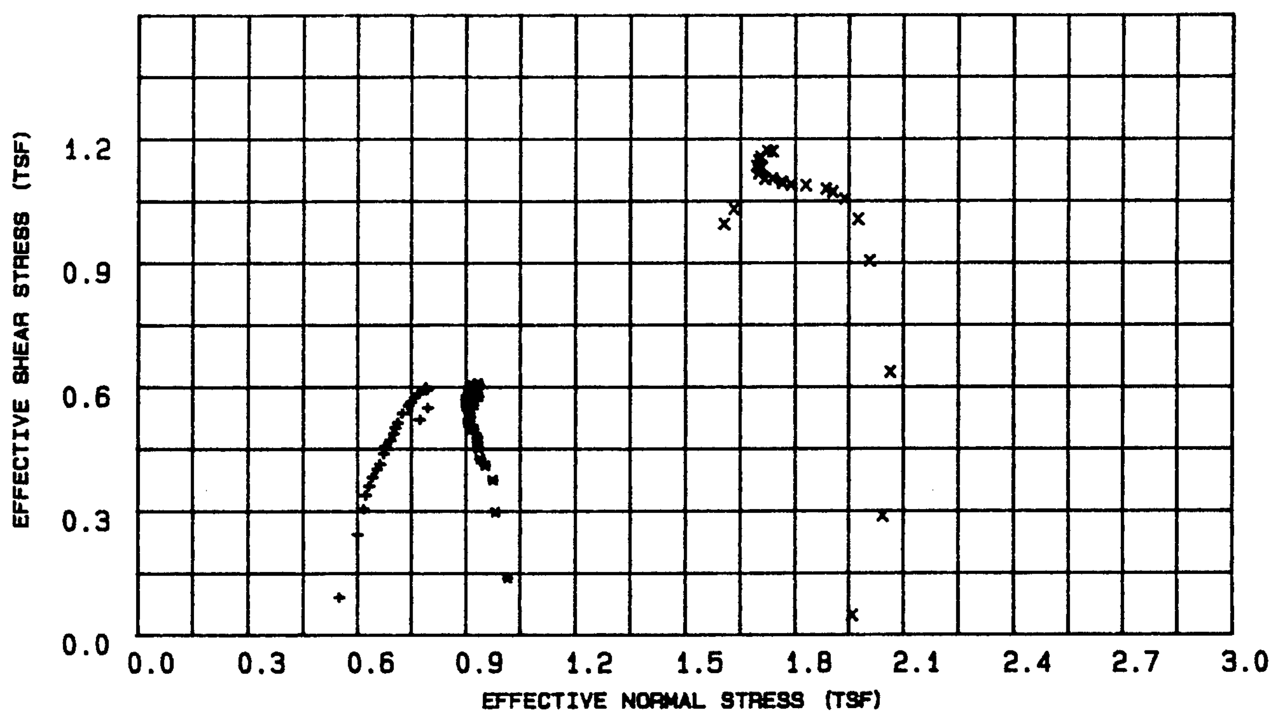
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

FIGURE 17



EFFECTIVE STRESS VECTOR CURVES ON 60 DEGREE PLANE



LEGEND

+ = .5 TSF

✱ = 1 TSF

X = 2 TSF

PROJECT	CHASKA FLOOD; CENCS-IA-93-30-ED-GH
BORING NO.	92-195MU
SAMPLE NO.	W-4
DEPTH/ELEV	23'-25'
MRD LAB NO.	1897

FIGURE 18

R

Table 10 - Triaxial $\bar{R}$ Test Results

Project : CHASKA FLOOD; CENCS-IA-93-30-ED-GH
Boring Number : 92-195MU
Sample Number : W-4
Depth : 23'-25'
Confining Pressure : .5 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.00	0.210	0.003	1.423	0.014	0.549	0.091
30	0.34	0.562	0.039	2.220	0.070	0.600	0.243
45	0.34	0.707	0.058	2.600	0.083	0.617	0.305
60	0.68	0.783	0.071	2.826	0.092	0.623	0.338
90	1.02	0.834	0.075	2.963	0.090	0.632	0.360
120	1.02	0.882	0.077	3.086	0.088	0.641	0.381
150	1.36	0.928	0.076	3.191	0.083	0.654	0.401
180	1.36	0.957	0.075	3.251	0.079	0.662	0.413
210	2.05	1.015	0.078	3.408	0.078	0.673	0.438
240	2.39	1.056	0.085	3.543	0.081	0.676	0.456
300	2.73	1.091	0.079	3.593	0.073	0.691	0.471
360	3.07	1.126	0.079	3.676	0.071	0.700	0.486
420	3.41	1.161	0.082	3.778	0.071	0.705	0.501
480	4.09	1.188	0.083	3.849	0.070	0.711	0.513
540	4.77	1.243	0.083	3.978	0.067	0.725	0.536
600	5.46	1.287	0.078	4.048	0.061	0.741	0.555
720	6.48	1.304	0.075	4.068	0.058	0.748	0.563
840	7.16	1.333	0.071	4.104	0.053	0.759	0.575
960	7.84	1.353	0.066	4.113	0.049	0.769	0.584
1080	9.55	1.373	0.055	4.088	0.041	0.785	0.593
1200	10.91	1.387	0.053	4.104	0.039	0.790	0.599
1320	12.62	1.374	0.046	4.026	0.034	0.794	0.593
1440	13.98	1.273	0.020	3.652	0.016	0.795	0.549
1511	15.00	1.204	0.025	3.534	0.021	0.773	0.520

Table 11 - Triaxial $\overline{R}$ Test Results

Project : CHASKA FLOOD; CENCS-IA-93-30-ED-GH
Boring Number : 92-195MU
Sample Number : W-4
Depth : 23'-25'
Confining Pressure : 1 TSF

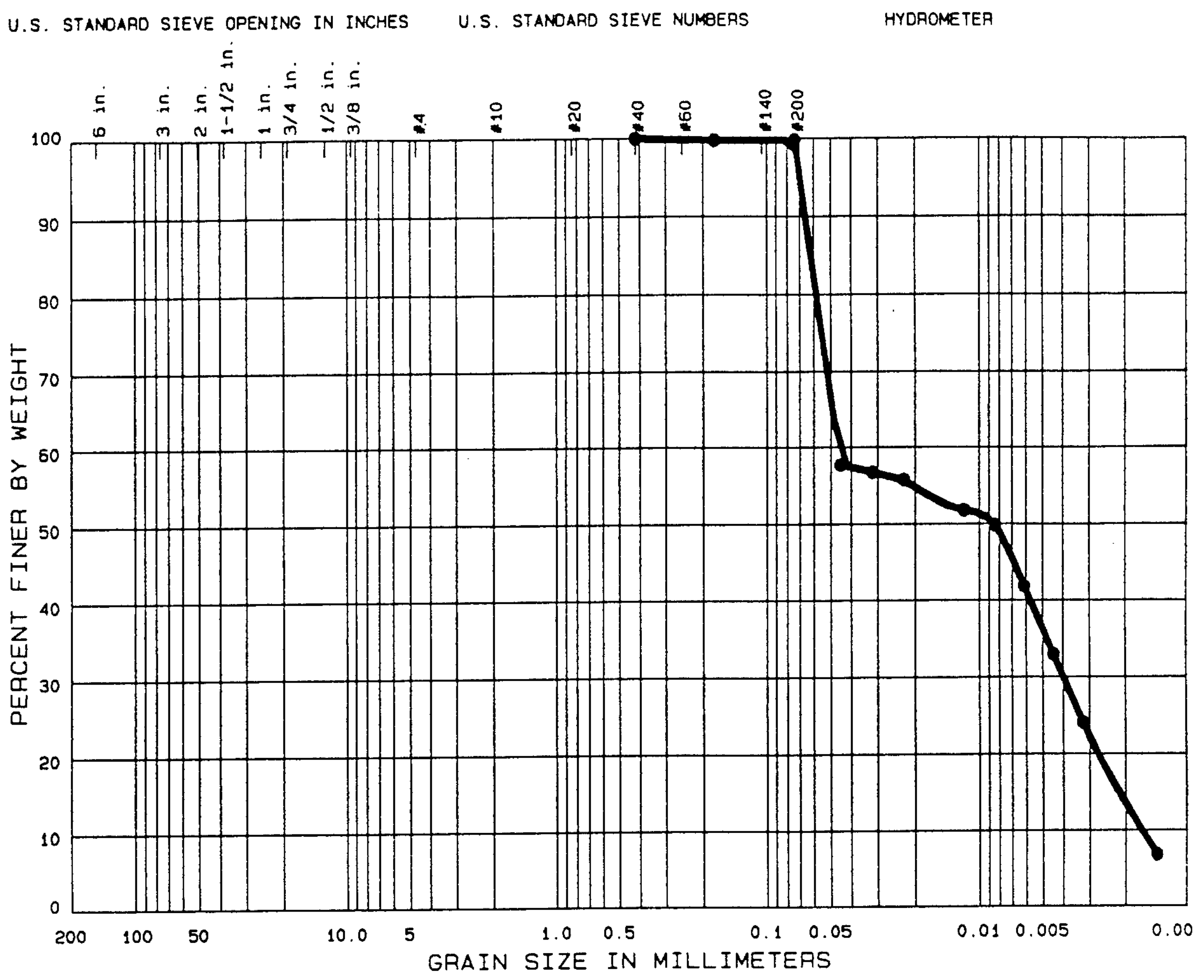
Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.00	0.320	0.063	1.341	0.196	1.016	0.138
30	0.34	0.691	0.189	1.852	0.274	0.982	0.298
45	0.34	0.869	0.241	2.145	0.278	0.974	0.375
60	0.69	0.949	0.282	2.322	0.298	0.953	0.410
90	1.03	0.985	0.305	2.417	0.310	0.939	0.425
120	1.03	1.048	0.325	2.551	0.310	0.934	0.452
150	1.37	1.079	0.336	2.625	0.312	0.931	0.466
180	1.37	1.107	0.343	2.687	0.311	0.931	0.478
210	2.06	1.154	0.366	2.822	0.318	0.920	0.498
240	2.40	1.190	0.388	2.944	0.327	0.906	0.513
300	2.74	1.224	0.392	3.015	0.321	0.911	0.528
360	3.08	1.249	0.401	3.086	0.321	0.908	0.539
420	3.43	1.270	0.407	3.140	0.321	0.907	0.548
480	4.11	1.282	0.416	3.195	0.325	0.901	0.553
540	4.80	1.321	0.427	3.305	0.324	0.900	0.570
600	5.48	1.350	0.425	3.348	0.315	0.909	0.583
720	6.51	1.362	0.430	3.388	0.316	0.907	0.588
840	7.19	1.381	0.432	3.431	0.313	0.910	0.596
960	7.88	1.399	0.426	3.436	0.305	0.920	0.604
1080	9.59	1.404	0.413	3.393	0.295	0.935	0.606
1200	10.96	1.412	0.417	3.422	0.296	0.933	0.609
1320	12.68	1.372	0.414	3.341	0.302	0.926	0.592
1440	14.05	1.336	0.397	3.218	0.298	0.934	0.577
1506	15.00	1.291	0.400	3.153	0.311	0.920	0.557

Table 12 - Triaxial $\overline{R}$ Test Results

Project : CHASKA FLOOD; CENCS-IA-93-30-ED-GH
Boring Number : 92-195MU
Sample Number : W-4
Depth : 23'-25'
Confining Pressure : 2 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.00	0.108	0.066	1.056	0.615	1.961	0.047
30	0.36	0.668	0.122	1.356	0.183	2.043	0.288
45	0.36	1.474	0.301	1.868	0.205	2.064	0.636
60	0.71	2.097	0.512	2.409	0.245	2.007	0.905
90	1.07	2.331	0.601	2.667	0.258	1.976	1.006
120	1.07	2.443	0.667	2.833	0.273	1.938	1.055
150	1.43	2.484	0.710	2.925	0.286	1.905	1.072
180	1.43	2.500	0.734	2.975	0.294	1.885	1.079
210	2.14	2.521	0.795	3.092	0.316	1.829	1.088
240	2.50	2.524	0.837	3.170	0.332	1.788	1.089
300	2.85	2.532	0.863	3.226	0.341	1.764	1.093
360	3.21	2.540	0.866	3.240	0.342	1.763	1.096
420	3.57	2.557	0.896	3.317	0.351	1.737	1.104
480	4.28	2.557	0.917	3.361	0.359	1.716	1.103
540	4.99	2.586	0.941	3.442	0.364	1.699	1.116
600	5.70	2.620	0.942	3.477	0.360	1.707	1.131
720	6.77	2.628	0.958	3.522	0.365	1.693	1.134
840	7.49	2.660	0.961	3.561	0.362	1.698	1.148
960	8.20	2.681	0.960	3.578	0.358	1.704	1.157
1080	9.98	2.711	0.933	3.541	0.345	1.738	1.170
1200	11.41	2.714	0.950	3.586	0.351	1.722	1.171
1320	13.19	2.616	0.948	3.487	0.363	1.700	1.129
1440	14.62	2.386	0.960	3.295	0.403	1.631	1.030
1465	15.00	2.304	0.967	3.228	0.423	1.604	0.994

W.O. No.
Req. No. CENCS-IA-93-30-ED-GH
Contract No.



	% COBBLES	% GRAVEL	% SAND	% SILT OR CLAY	
●	0.0	0.0	0.2	63.6	36.2

	Sample No.	Elev or Depth	Nat W%	LL	PL	PI	C_c	C_u
●	W-4	23.0'-25.0'		76	60	16	0.21	28.0

CLASSIFICATION

● ELASTIC SILT, MH

Remarks:

Project CHASKA FLOOD CONTROL

Lab No. 1897

Area

Boring No. 92-195MU Date 2-18-93

GRADATION CURVES

CORPS OF ENGINEERS, MISSOURI RIVER DIVISION LAB
420 SOUTH 18th STREET - OMAHA, NE 68102-2586

Figure 19 FIG D-329

CLASSIFICATION TEST REQUEST

PROJECT: Chaska Flood control

MRD LAB. NO.: 1897

ACCOMPANYING TEST: Q, R

REQUEST NO. CEMCS-IA-93-30 ED-GH

CONTAINER - TYPE: 5" Wax

NO.:

SAMPLE IDENTIFICATION: 92-195MV U-4 23.0-25.0

SAMPLE IDENTIFICATION:

Structure: ( ) Brittle (X) Plastic ( )

Consistency: Undisturbed ( ) Soft (X) Med ( ) Stiff ( ) Hard

Remolded ( ) Insensitive (X) Sl. Sens. ( ) Sensitive

PL Thread: Strength ( ) Low ( ) Med (X) High ( )

Shine ( ) None ( ) Dull (X) Gloss ( ) H. Gloss ( )

Shake Test ( ) None (X) Slow ( ) Fast ( ) Rapid ( )

Torvane: .3 TSF

Color: gray

Disturbance:

Est. Max. Particle Size:

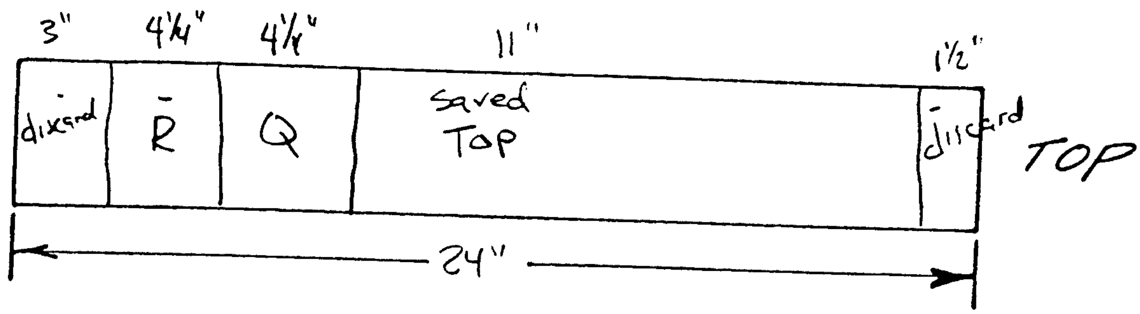
Remarks:

Odor: None

Cementation: reactive to HCl

Date Core Opened: 2/10/93

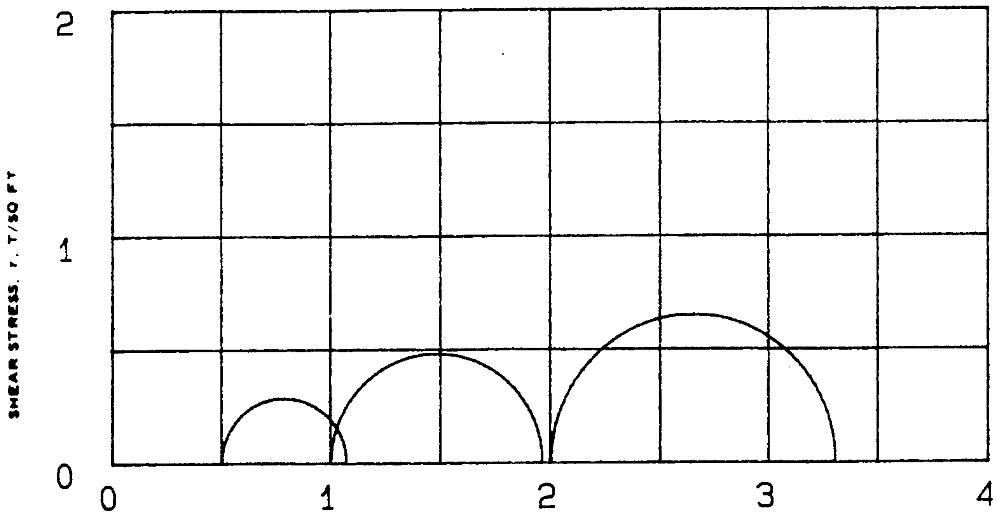
Sketch: (Core description and specimen location)

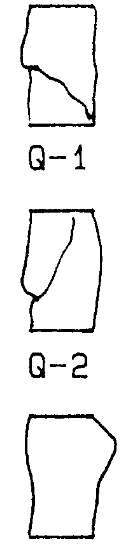


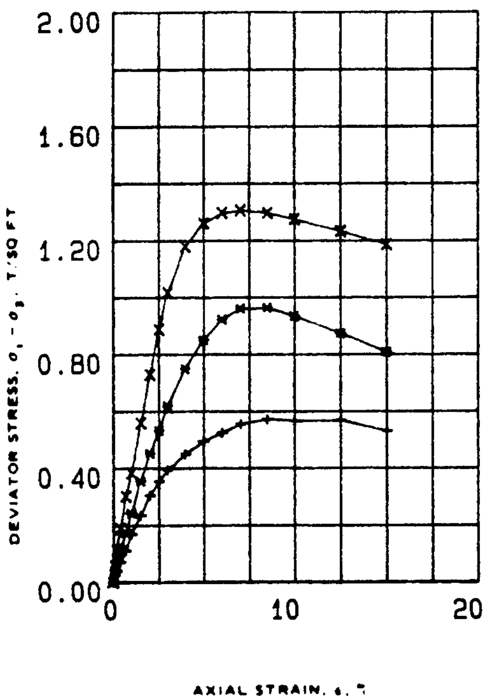
Technician MJW

Figure 20

FIGURE D-330







NORMAL STRESS, σ, T/SQ FT

SPECIMEN NO.			1 (+)	2 (*)	3 (X)
INITIAL	WATER CONTENT, %	w_o	107.3	98.1	97.7
	DRY DENSITY LB/CU FT	γd_o	40.3	41.9	42.8
	SATURATION, %	S_o	94.0	91.0	93.0
	VOID RATIO	e_o	2.76	2.63	2.54
BEFORE SHEAR	WATER CONTENT, %	w_c	97.6	99.3	91.1
	DRY DENSITY LB/CU FT	γd_c	40.5	41.6	43.2
	SATURATION, %	S_c	86.0	91.0	88.0
	VOID RATIO	e_c	2.75	2.64	2.51
	FINAL BACK PRESSURE, T/SQ FT	u_o	0.0	0.0	0.0
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	0.5	1.0	2.0
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	0.57	0.96	1.31
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	17.5	16.8	13.0
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	0.53	0.81	1.19
INITIAL DIAMETER, IN.		D_o	1.39	1.39	1.39
INITIAL HEIGHT, IN.		H_o	3.00	3.00	3.00

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Organic silty sand, SM

LL 122	PL 84	PI 38	G_s 2.43	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST Q

REMARKS Dark grayish-brown. Torvane = 0.45 TSF. Highly calcareous.

PROJECT CHASKA FLOOD; IA-93-30

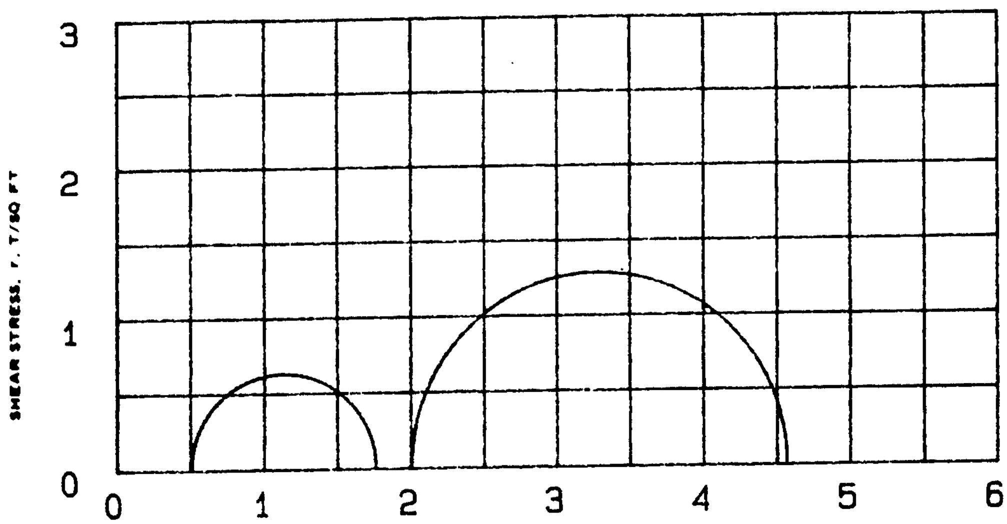
BORING NO 92-195 MU — SAMPLE NO. W-5

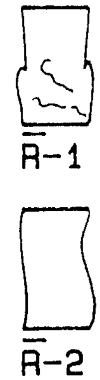
DEPTH ELEV 36'-38'

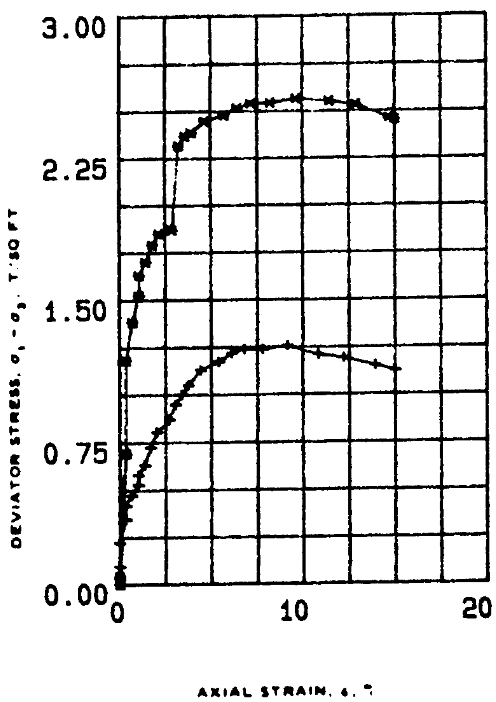
LABORATORY 1897 — DATE 2-11-93

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 — PREVIOUS EDITION IS OBSOLETE — TRANSLUCENT — (EM 1110-2-1906) — FIGURE 21







CONTROLLED- STRAIN TEST

SPECIMEN NO.			1 (+)	2 (x)		
INITIAL	WATER CONTENT, %	w_o	105.3	105.2		
	DRY DENSITY LB/CU FT	γ_{d_o}	39.3	39.9		
	SATURATION, %	S_o	90	91		
	VOID RATIO	e_o	2.86	2.8		
BEFORE SHEAR	WATER CONTENT, %	w_c	108.5	83.8		
	DRY DENSITY LB/CU FT	γ_{d_c}	41.7	49.9		
	SATURATION, %	S_c	100	100		
	VOID RATIO	e_c	2.64	2.04		
	FINAL BACK PRESSURE, T/SQ FT	u_o	4.103	4.103		
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.5	2		
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	1.256	2.566		
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	1080	1080		
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	1.121	2.453		
INITIAL DIAMETER, IN.		D_o	1.39	1.41		
INITIAL HEIGHT, IN.		H_o	3.01	3		
B-Value			1.0	1.0	1.0	

Description of Specimens: Organic silty sand, SM

LL	PL	PI	G_s
122	84	38	2.43

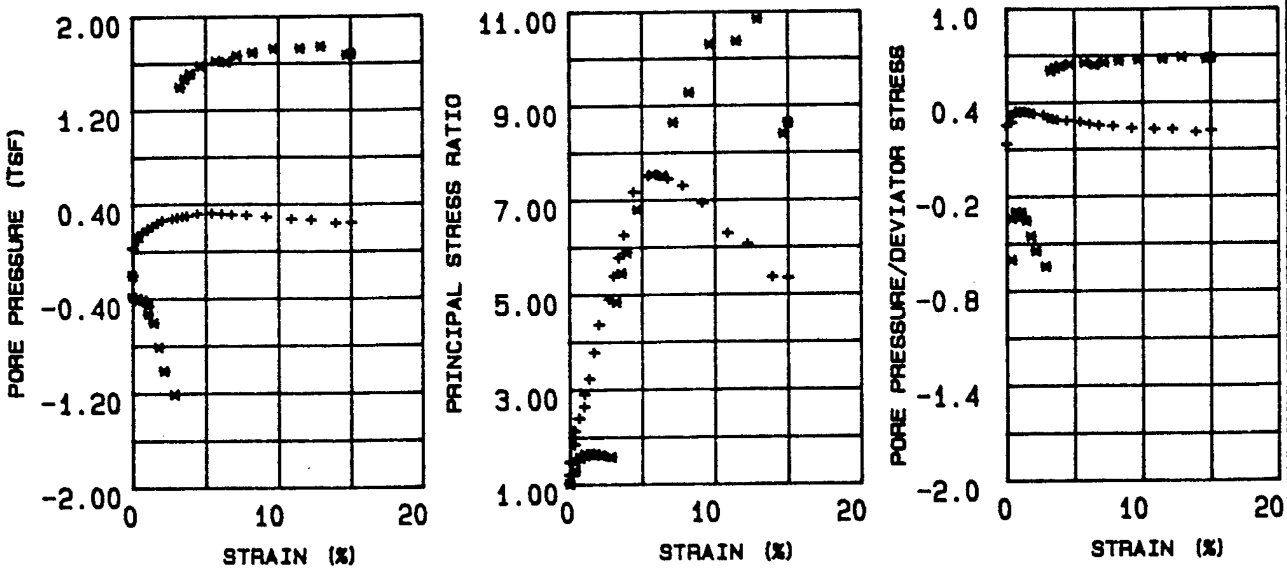
REMARKS. Dark grayish-brown. Torvane = 0.45 TSF. Highly calcareous. Wood chips and organic matter throughout the sample.

TYPE OF SPECIMEN	UNDISTURBED	TYPE OF TEST	R-BAR
PROJECT	CHASKA FLOOD; CENCS-IA-93-30-ED-GH		
BORING NO	92-195MU	SAMPLE NO.	N-5
DEPTH ELEV	36.0'-38.0'		
LABORATORY	1897	DATE	3-11-93

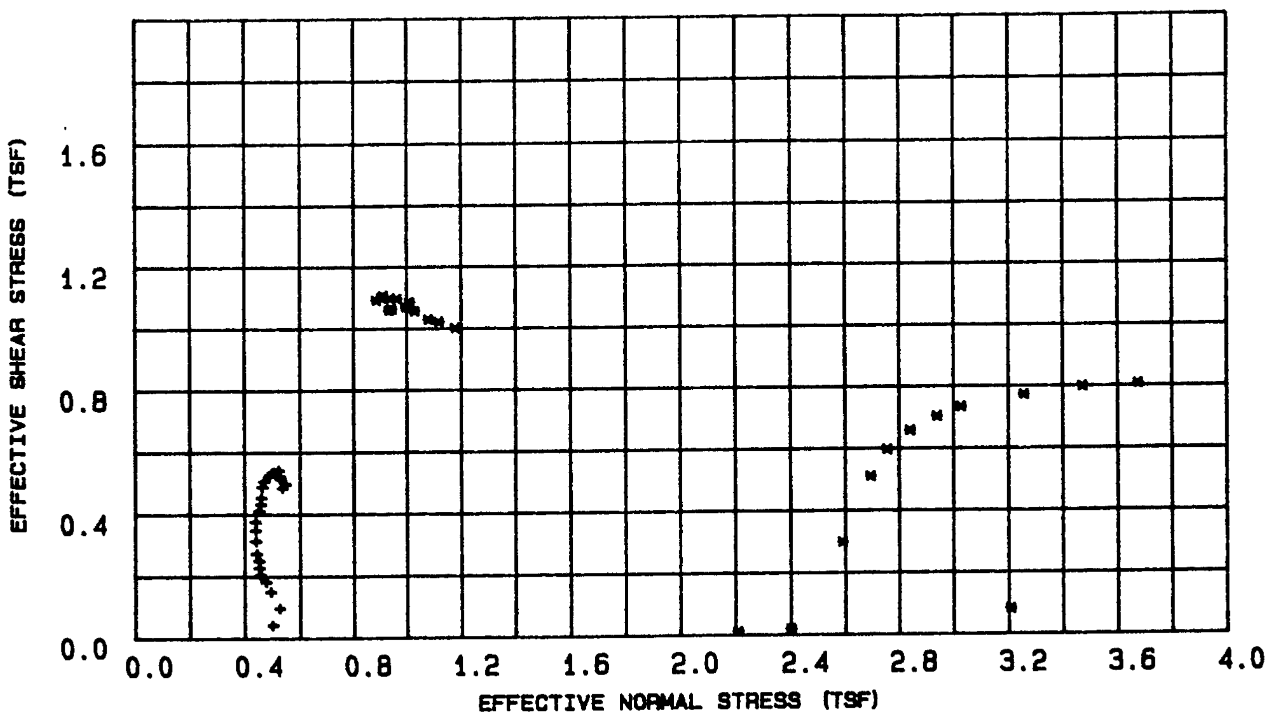
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

FIGURE 22



EFFECTIVE STRESS VECTOR CURVES ON 60 DEGREE PLANE



LEGEND

+ = .5 TSF

* = 2 TSF

PROJECT	CHASKA FLOOD; CENCS-IA-93-30-ED-GH
BORING NO.	92-195MU
SAMPLE NO.	W-5
DEPTH/ELEV	36.0'-38.0'
MRD LAB NO.	1897

FIGURE 23

Table 13 - Triaxial $\bar{R}$ Test Results

Project : CHASKA FLOOD; CENCS-IA-93-30-ED-GH
Boring Number : 92-195MU
Sample Number : W-5
Depth : 36.0'-38.0'
Confining Pressure : .5 TSF

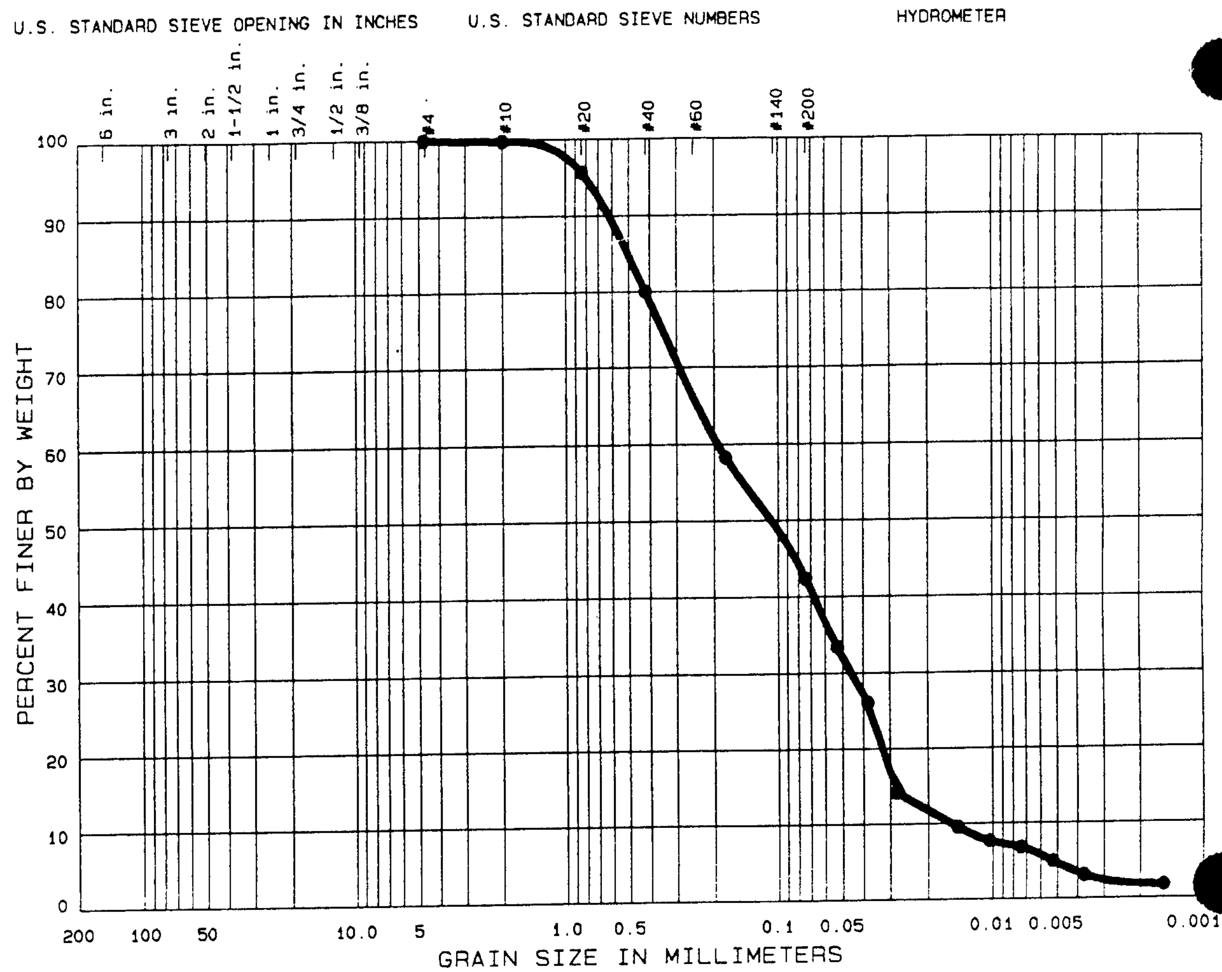
Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.00	0.095	0.024	1.199	0.252	0.499	0.041
30	0.00	0.222	0.030	1.473	0.133	0.525	0.096
45	0.34	0.346	0.094	1.851	0.271	0.492	0.149
60	0.34	0.419	0.130	2.134	0.311	0.474	0.181
90	0.68	0.473	0.162	2.400	0.343	0.455	0.204
120	1.02	0.527	0.179	2.642	0.341	0.451	0.227
150	1.02	0.580	0.194	2.899	0.336	0.450	0.250
180	1.36	0.633	0.215	3.224	0.340	0.442	0.273
210	1.69	0.725	0.240	3.784	0.331	0.439	0.313
240	2.03	0.805	0.261	4.365	0.324	0.438	0.348
300	2.71	0.870	0.277	4.904	0.319	0.438	0.375
360	3.05	0.949	0.284	5.389	0.299	0.451	0.410
420	3.39	1.000	0.291	5.781	0.291	0.457	0.432
480	3.73	1.050	0.300	6.255	0.286	0.460	0.453
540	4.41	1.130	0.317	7.168	0.281	0.463	0.488
600	5.42	1.173	0.320	7.506	0.273	0.470	0.506
720	6.10	1.218	0.313	7.521	0.258	0.489	0.526
840	6.78	1.239	0.307	7.437	0.249	0.500	0.535
960	7.80	1.239	0.303	7.292	0.245	0.504	0.535
1080	9.15	1.256	0.288	6.926	0.230	0.523	0.542
1200	10.85	1.208	0.271	6.284	0.225	0.528	0.521
1320	12.20	1.189	0.265	6.057	0.223	0.529	0.513
1440	13.90	1.149	0.236	5.355	0.206	0.548	0.496
1517	15.00	1.121	0.241	5.332	0.216	0.536	0.484

Table 14 - Triaxial $\bar{R}$ Test Results

Project : CHASKA FLOOD; CENCS-IA-93-30-ED-GH
Boring Number : 92-195MU
Sample Number : W-5
Depth : 36.0'-38.0'
Confining Pressure : 2 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.00	0.025	-0.202	1.012	-7.959	2.208	0.011
30	0.00	0.042	-0.390	1.017	-9.379	2.400	0.018
45	0.36	0.694	-0.418	1.287	-0.602	2.590	0.299
60	0.36	1.183	-0.401	1.493	-0.339	2.694	0.511
90	0.72	1.384	-0.413	1.574	-0.298	2.756	0.597
120	1.07	1.524	-0.464	1.619	-0.304	2.841	0.658
150	1.07	1.631	-0.535	1.643	-0.327	2.939	0.704
180	1.43	1.701	-0.607	1.652	-0.356	3.028	0.734
210	1.79	1.791	-0.813	1.637	-0.453	3.257	0.773
240	2.15	1.850	-1.014	1.614	-0.548	3.472	0.798
300	2.87	1.870	-1.213	1.582	-0.648	3.676	0.807
360	3.22	2.319	1.396	4.839	0.603	1.178	1.001
420	3.58	2.368	1.468	5.453	0.620	1.118	1.022
480	3.94	2.387	1.512	5.891	0.634	1.079	1.030
540	4.66	2.448	1.578	6.795	0.645	1.028	1.057
600	5.73	2.480	1.621	7.538	0.654	0.993	1.070
720	6.45	2.518	1.613	7.504	0.641	1.010	1.087
840	7.16	2.541	1.668	8.642	0.657	0.961	1.097
960	8.24	2.544	1.693	9.278	0.666	0.937	1.098
1080	9.67	2.566	1.724	10.309	0.673	0.911	1.107
1200	11.46	2.551	1.728	10.379	0.678	0.904	1.101
1320	12.89	2.531	1.743	10.852	0.689	0.884	1.092
1440	14.68	2.462	1.667	8.390	0.677	0.943	1.063
1461	15.00	2.453	1.677	8.623	0.684	0.931	1.059

W.O. No. CH92195W5
Req. No. CENCS-IA-93-30-ED-GH
Contract No.



	% COBBLES	% GRAVEL	% SAND	% SILT OR CLAY	
●	0.0	0.0	57.6	37.8	4.6

	Sample No.	Elev or Depth	Nat W%	LL	PL	PI	C_c	C_u
●	W-5	36.0'-38.0'		122	84	38	0.70	12.4

CLASSIFICATION

● ORGANIC SILTY SAND, SM
SPECIFIC GRAVITY=2.43

Remarks:

Project CHASKA FLOOD CONTROL
EAST CREEK, STAGE 3
Lab No. 1897
Area
Boring No. 92-195MU Date 02/18/93

GRADATION CURVES

CORPS OF ENGINEERS, MISSOURI RIVER DIVISION LAB
420 SOUTH 18th STREET - OMAHA, NE 68102-2586

Figure 24
FIGURE D-336

CLASSIFICATION TEST REQUEST

PROJECT: Chaska Flood Control

MRD LAB. NO.: 1897

ACCOMPANYING TEST: Q, R

REQUEST NO. CENCS-IA-93-30-ED-GH

CONTAINER - TYPE: 5" Wax

NO.:

SAMPLE IDENTIFICATION: 92-195MU W-5 36.0-38.0'

SAMPLE IDENTIFICATION:

Structure: (X) Brittle ( ) Plastic ( )

Consistency: Undisturbed ( ) Soft (X) Med ( ) Stiff ( ) Hard

Remolded (X) Insensitive ( ) Sl. Sens. ( ) Sensitive

PL Thread: Strength (X) Low ( ) Med ( ) High ( )

Shine (X) None ( ) Dull ( ) Gloss ( ) H. Gloss ( )

Shake Test ( ) None ( ) Slow (X) Fast ( ) Rapid ( )

Torvane: .45 TSF

Color: Dark grayish brown

Disturbance:

Est. Max. Particle Size:

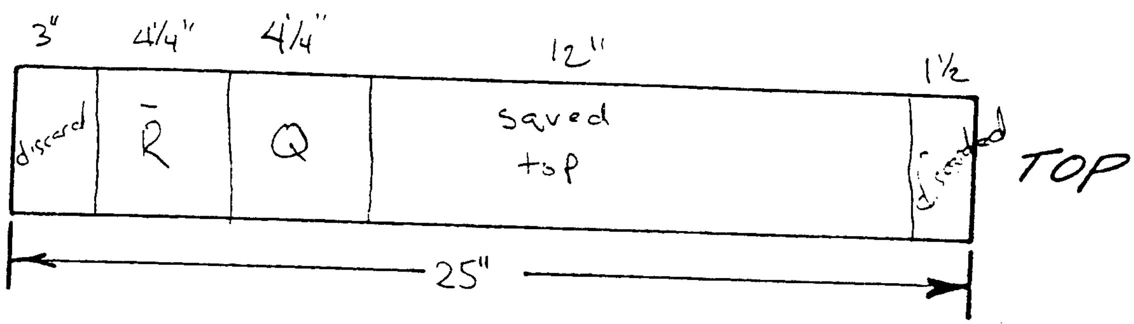
Remarks:

Odor: None

Cementation: Highly reactive to HCl

Date Core Opened: 2/11/93

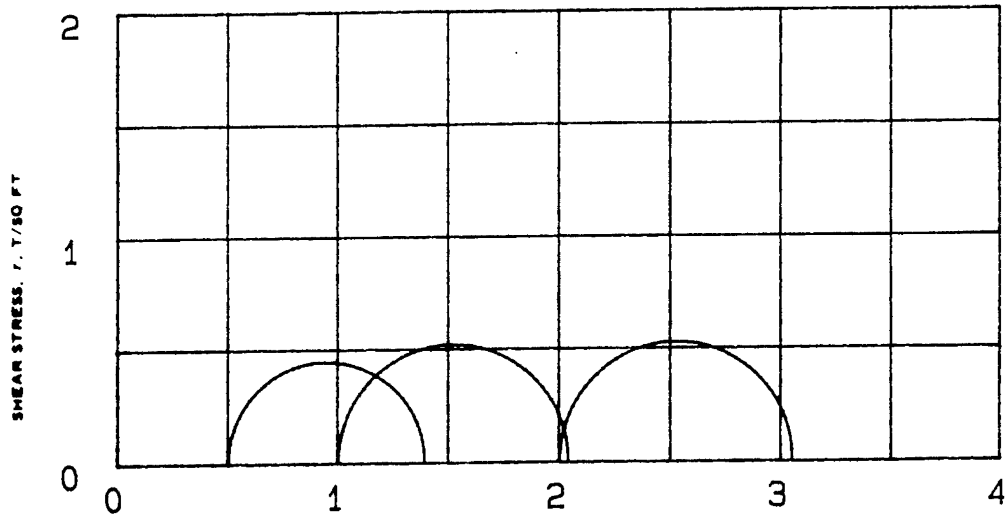
Sketch: (Core description and specimen location)

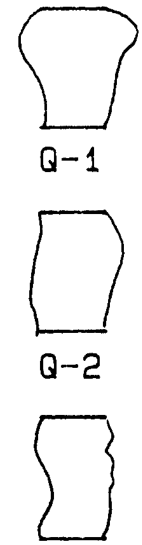


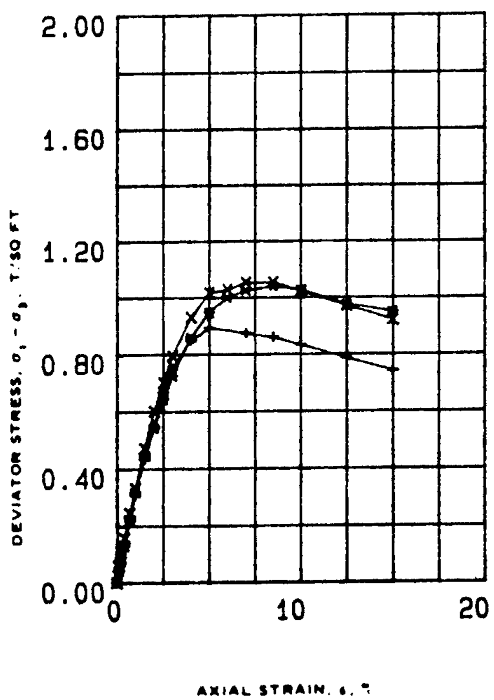
Technician MJW

Figure 25

FIGURE D-337







				1 (+)	2 (*)	3 (X)	
SPECIMEN NO.				1 (+)	2 (*)	3 (X)	
INITIAL	WATER CONTENT, %		w_o	103.4	100.6	113.1	
	DRY DENSITY LB/CU FT		γd_o	41.0	42.2	37.4	
	SATURATION, %		S_o	92.0	93.0	89.0	
	VOID RATIO		e_o	2.81	2.70	3.18	
BEFORE SHEAR	WATER CONTENT, %		w_c	104.7	97.5	119.6	
	DRY DENSITY LB/CU FT		γd_c	41.1	42.3	37.7	
	SATURATION, %		S_c	94.0	91.0	95.0	
	VOID RATIO		e_c	2.79	2.69	3.14	
	FINAL BACK PRESSURE, T/SQ FT		u_o	0.0	0.0	0.0	
MINOR PRINCIPAL STRESS, T/SQ FT			σ_3	0.5	1.0	2.0	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$		0.89	1.04	1.05	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN			t_f	8.5	16.8	16.5	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$		0.74	0.95	0.92	
INITIAL DIAMETER, IN			D_o	1.37	1.38	1.38	
INITIAL HEIGHT, IN			H_o	3.00	3.00	3.00	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Silty sand with organics, SM

LL 89	PL 68	PI 21	G_s 2.5	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST Q

REMARKS Yellowish-brown. Torvane = 0.42 TSF. Calcareous.

PROJECT CHASKA FLOOD C.P.; IA-93-30

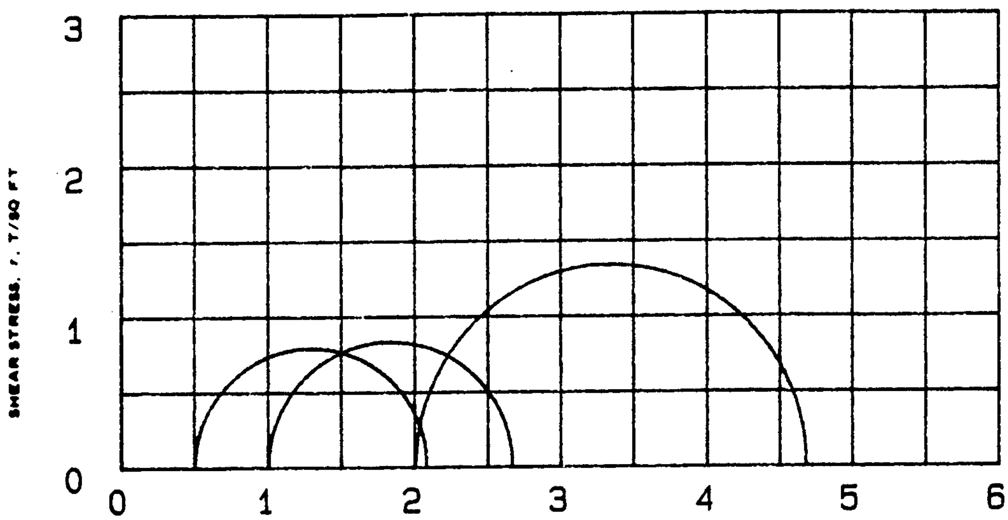
BORING NO 92-195 MU SAMPLE NO. W-6

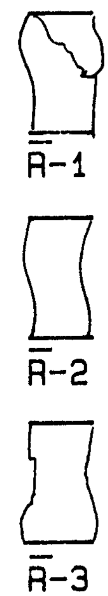
DEPTH ELEV 38.0'-40.0'

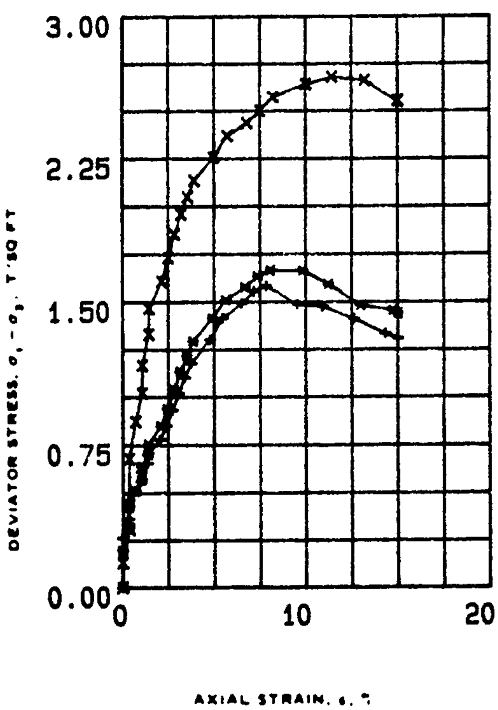
LABORATORY 1897 DATE 2-22-93

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906) FIGURE 26







NORMAL STRESS, σ, T/SQ FT

			SPECIMEN NO.	1 (+)	2 (*)	3 (X)	
INITIAL	WATER CONTENT, %	w_o		148.7	162.1	148.6	
	DRY DENSITY LB/CU FT	γd_o		31.6	28.7	31.4	
	SATURATION, %	S_o		94	91	94	
	VOID RATIO	e_o		3.94	4.44	3.97	
BEFORE SHEAR	WATER CONTENT, %	w_c		156.5	176	126.2	
	DRY DENSITY LB/CU FT	γd_c		33.7	33.3	38.2	
	SATURATION, %	S_c		100	100	100	
	VOID RATIO	e_c		3.63	3.69	3.09	
	FINAL BACK PRESSURE, T/SQ FT	u_o		3.383	3.383	3.383	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3		.5	1	2	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$		1.582	1.664	2.679	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f		960	960	1200	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$		1.306	1.438	2.550	
INITIAL DIAMETER, IN.		D_o		1.38	1.39	1.38	
INITIAL HEIGHT, IN.		H_o		3	2.99	2.99	
B-Value				1.0	1.0	1.0	

CONTROLLED- STRAIN TEST

Description of Specimens: Silty sand with organics, SM

LL 89	PL 68	PI 21	G 2.5	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST RBAR

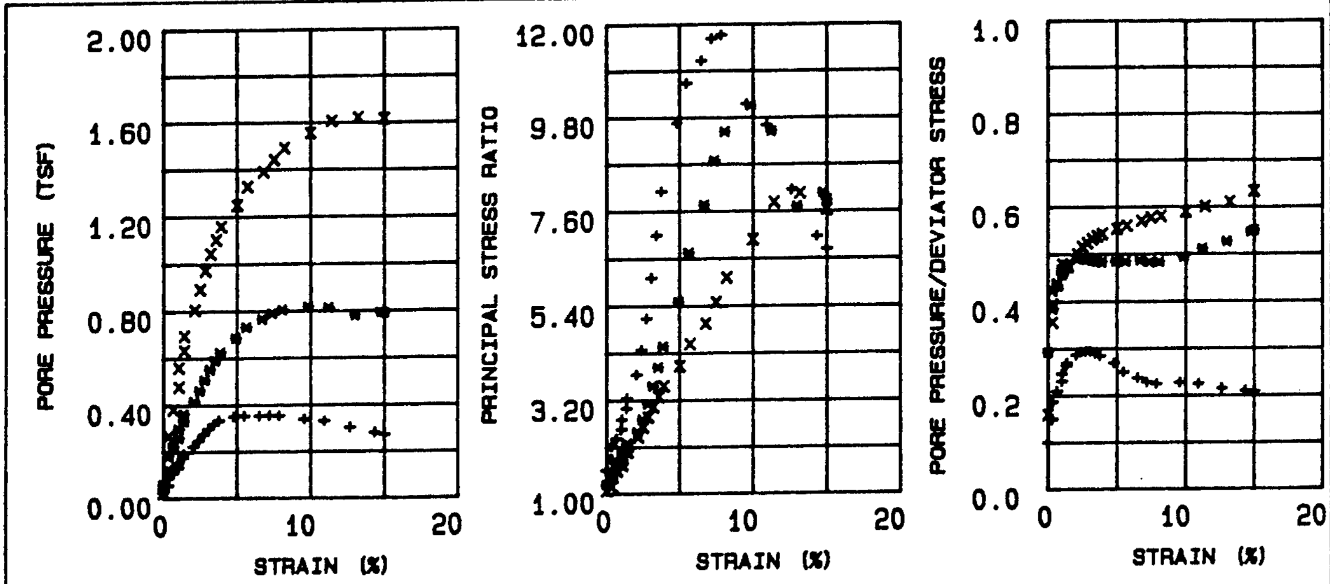
REMARKS: Yellowish-brown. Torvane = 0.42 TSF. Calcareous.

PROJECT	CHASKA FLOOD; CENCS-IA-93-30-ED-GH
BORING NO	92-195MU
SAMPLE NO.	W-6
DEPTH ELEV	38.0'-40.0'
LABORATORY	1897
DATE	3-5-93

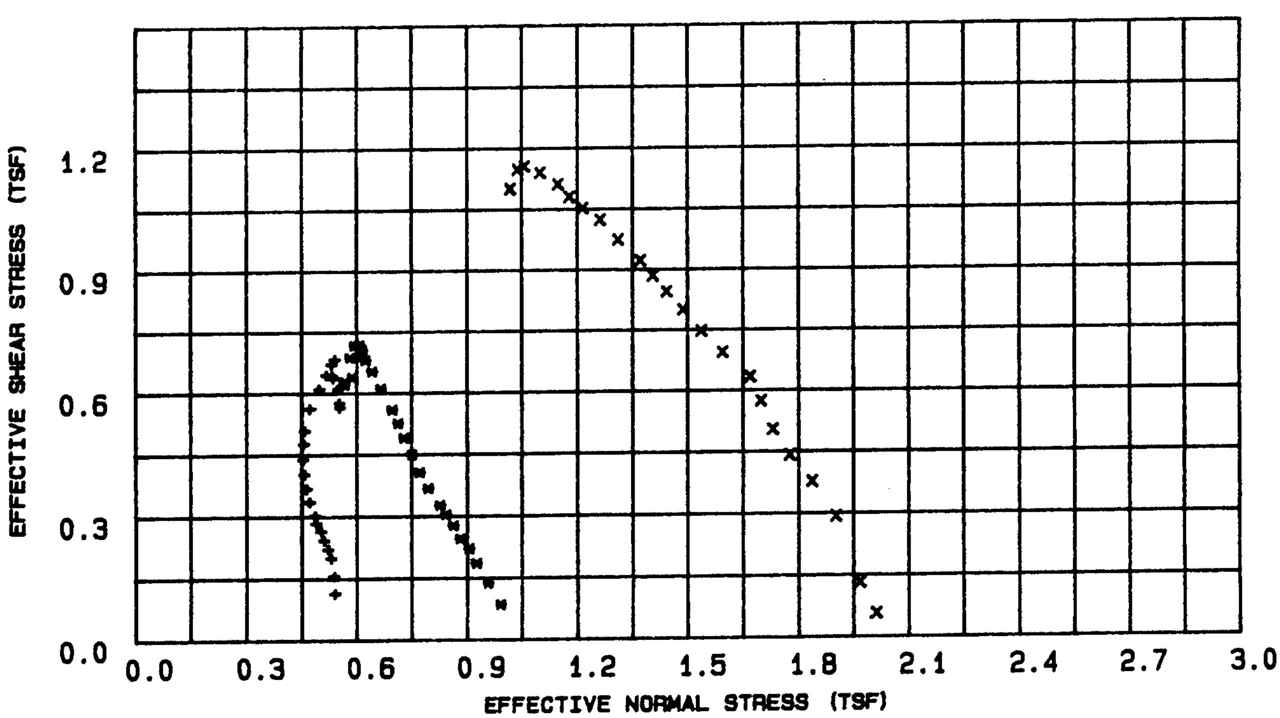
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO 2089
REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

FIGURE 27



EFFECTIVE STRESS VECTOR CURVES ON 60 DEGREE PLANE



LEGEND

+ = .5 TSF
* = 1 TSF
X = 2 TSF

PROJECT	CHASKA FLOOD; CENCS-IA-93-30-ED-GH
BORING NO.	92-185MU
SAMPLE NO.	W-6
DEPTH/ELEV	38.0'-40.0'
MRD LAB NO.	1897

FIGURE 28

Table 15 - Triaxial $\overline{R}$ Test Results

Project : CHASKA FLOOD; CENCS-IA-93-30-ED-GH
Boring Number : 92-195MU
Sample Number : W-6
Depth : 38.0'-40.0'
Confining Pressure : .5 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.00	0.262	0.026	1.552	0.100	0.539	0.113
30	0.34	0.362	0.054	1.813	0.150	0.536	0.156
45	0.34	0.462	0.086	2.117	0.187	0.528	0.199
60	0.68	0.512	0.107	2.304	0.210	0.520	0.221
90	1.02	0.562	0.130	2.517	0.231	0.509	0.242
120	1.02	0.611	0.150	2.749	0.247	0.501	0.264
150	1.36	0.655	0.174	3.008	0.265	0.488	0.283
180	1.36	0.700	0.189	3.248	0.270	0.484	0.302
210	2.05	0.777	0.222	3.800	0.287	0.470	0.335
240	2.39	0.849	0.248	4.376	0.293	0.462	0.367
300	2.73	0.931	0.274	5.112	0.294	0.456	0.402
360	3.07	1.017	0.299	6.053	0.294	0.453	0.439
420	3.41	1.102	0.318	7.038	0.289	0.455	0.476
480	3.75	1.177	0.333	8.061	0.284	0.458	0.508
540	4.77	1.302	0.350	9.677	0.269	0.472	0.562
600	5.46	1.414	0.353	10.609	0.250	0.497	0.610
720	6.48	1.492	0.353	11.137	0.237	0.516	0.644
840	7.16	1.554	0.354	11.661	0.228	0.531	0.671
960	7.84	1.582	0.353	11.747	0.224	0.539	0.683
1080	9.55	1.486	0.337	10.117	0.227	0.531	0.642
1200	10.91	1.473	0.329	9.616	0.224	0.536	0.636
1320	12.62	1.410	0.301	8.086	0.214	0.548	0.609
1440	14.32	1.332	0.278	6.997	0.209	0.552	0.575
1499	15.00	1.306	0.270	6.697	0.208	0.553	0.564

Table 16 - Triaxial $\bar{R}$ Test Results

Project : CHASKA FLOOD; CENCS-IA-93-30-ED-GH
Boring Number : 92-195MU
Sample Number : W-6
Depth : 38.0'-40.0'
Confining Pressure : 1 TSF

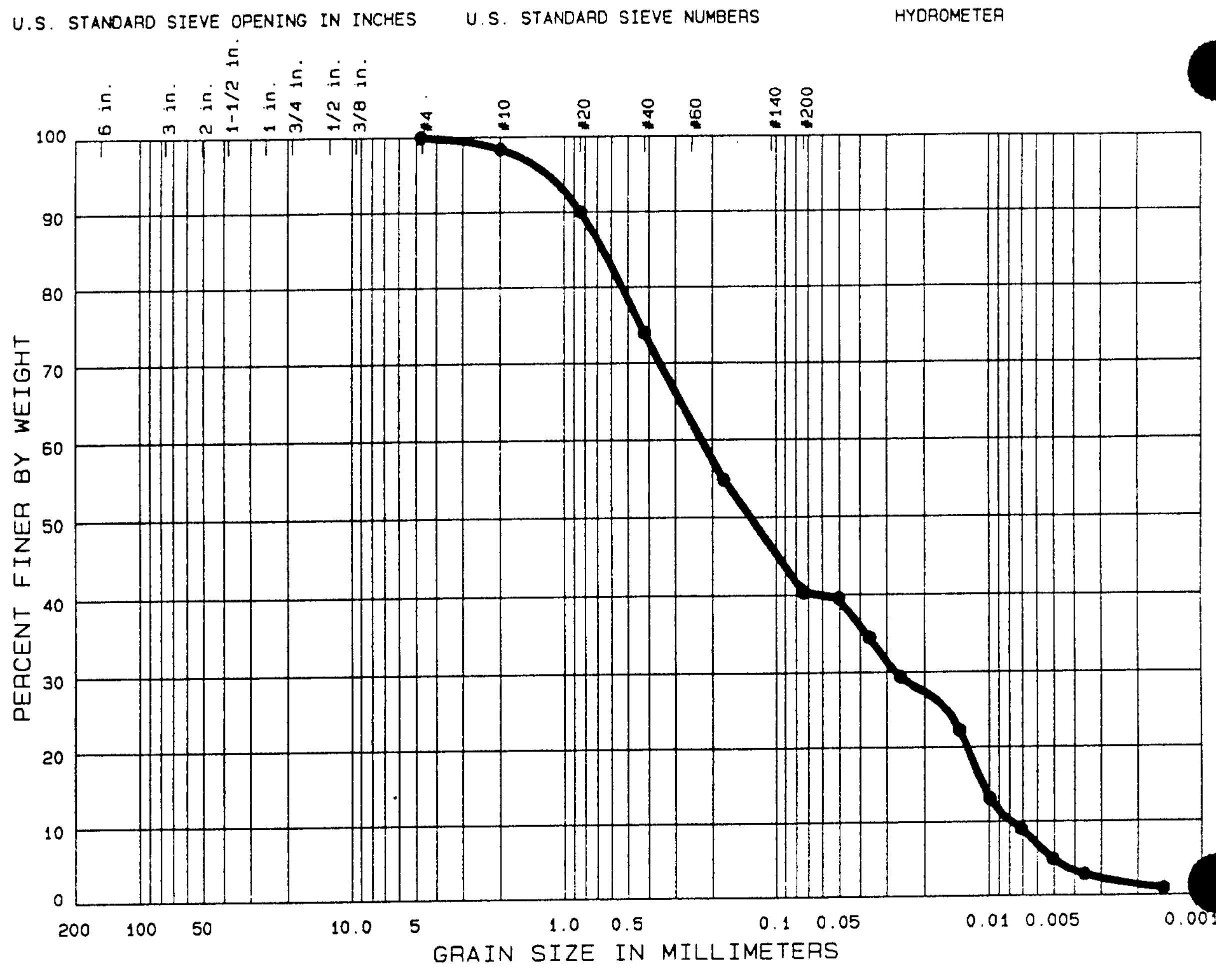
Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.00	0.197	0.058	1.209	0.293	0.991	0.085
30	0.35	0.318	0.122	1.362	0.385	0.957	0.137
45	0.35	0.428	0.181	1.522	0.423	0.925	0.185
60	0.70	0.512	0.222	1.657	0.434	0.905	0.221
90	1.05	0.569	0.260	1.768	0.458	0.881	0.245
120	1.05	0.641	0.297	1.913	0.464	0.862	0.277
150	1.40	0.703	0.332	2.052	0.473	0.842	0.303
180	1.40	0.755	0.361	2.180	0.479	0.826	0.326
210	2.11	0.850	0.416	2.456	0.490	0.794	0.367
240	2.46	0.940	0.462	2.749	0.492	0.771	0.406
300	2.81	1.041	0.508	3.117	0.489	0.750	0.449
360	3.16	1.135	0.552	3.535	0.487	0.729	0.490
420	3.51	1.219	0.590	3.970	0.484	0.712	0.526
480	3.86	1.296	0.625	4.456	0.483	0.696	0.559
540	4.91	1.416	0.685	5.490	0.484	0.666	0.611
600	5.62	1.512	0.732	6.632	0.484	0.642	0.653
720	6.67	1.577	0.766	7.742	0.486	0.624	0.681
840	7.37	1.635	0.790	8.782	0.483	0.615	0.706
960	8.07	1.664	0.804	9.468	0.483	0.608	0.718
1080	9.83	1.661	0.817	10.084	0.493	0.594	0.717
1200	11.23	1.591	0.812	9.472	0.511	0.582	0.687
1320	12.99	1.481	0.779	7.704	0.526	0.588	0.639
1440	14.74	1.454	0.793	8.016	0.546	0.567	0.628
1462	15.00	1.438	0.790	7.849	0.550	0.566	0.621

Table 17 - Triaxial $\bar{R}$ Test Results

Project : CHASKA FLOOD; CENCS-IA-93-30-ED-GH
Boring Number : 92-195MU
Sample Number : W-6
Depth : 38.0'-40.0'
Confining Pressure : 2 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.00	0.131	0.021	1.066	0.160	2.011	0.056
30	0.36	0.306	0.109	1.162	0.356	1.967	0.132
45	0.36	0.677	0.266	1.390	0.394	1.901	0.292
60	0.71	0.871	0.380	1.538	0.437	1.836	0.376
90	1.07	1.021	0.477	1.670	0.467	1.776	0.441
120	1.07	1.167	0.559	1.810	0.479	1.730	0.504
150	1.43	1.331	0.632	1.973	0.475	1.698	0.574
180	1.43	1.466	0.694	2.122	0.474	1.669	0.633
210	2.14	1.608	0.804	2.344	0.500	1.594	0.694
240	2.50	1.731	0.892	2.562	0.516	1.537	0.747
300	2.85	1.853	0.971	2.800	0.524	1.488	0.800
360	3.21	1.959	1.042	3.045	0.532	1.443	0.845
420	3.57	2.048	1.102	3.279	0.538	1.405	0.884
480	3.92	2.136	1.158	3.536	0.543	1.371	0.922
540	4.99	2.256	1.248	4.001	0.554	1.310	0.974
600	5.71	2.370	1.326	4.513	0.560	1.261	1.023
720	6.78	2.437	1.389	4.988	0.570	1.214	1.052
840	7.49	2.501	1.441	5.478	0.577	1.178	1.080
960	8.21	2.574	1.490	6.051	0.580	1.147	1.111
1080	9.99	2.641	1.555	6.937	0.589	1.099	1.140
1200	11.42	2.679	1.606	7.804	0.600	1.057	1.156
1320	13.20	2.660	1.621	8.014	0.610	1.038	1.148
1440	14.98	2.551	1.615	7.626	0.633	1.017	1.101
1441	15.00	2.550	1.615	7.619	0.633	1.017	1.100

W.O. No. CH92195W6
Req. No. CENCS-IA-93-30-ED-GH
Contract No.



% COBBLES		% GRAVEL	% SAND	% SILT OR CLAY	
●	0.0	0.0	59.6	35.6	4.8

	Sample No.	Elev or Depth	Nat W%	LL	PL	PI	C_c	C_u
●	W-6	38.0'-40.0'		89	68	21	0.42	28.5

CLASSIFICATION

● SILTY SAND, SM, WITH ORGANICS
SPECIFIC GRAVITY = 2.50

Remarks:

Project CHASKA FLOOD CONTROL
EAST CREEK, STAGE 3
Lab No. 1897
Area
Boring No. 92-195MU Date 02/22/93

GRADATION CURVES

CORPS OF ENGINEERS, MISSOURI RIVER DIVISION LAB
420 SOUTH 18th STREET - OMAHA, NE 68102-2586

Figure 29 FIG D3

CLASSIFICATION TEST REQUEST

PROJECT: Chaska Flood Control

ACCOMPANYING TEST: Q, R

CONTAINER - TYPE: 5" Wax

SAMPLE IDENTIFICATION: 92-195MU U-6 38.0'-40.0'

MRD LAB. NO.: 1897

REQUEST NO. CENCS-IA-93-30-ED-GH

NO.:

SAMPLE IDENTIFICATION:

Structure: (✓) Brittle ( ) Plastic ( )

Consistency: Undisturbed ( ) Soft (✓) Med ( ) Stiff ( ) Hard

Remolded (✓) Insensitive ( ) Sl. Sens. ( ) Sensitive

PL Thread: Strength (✓) Low ( ) Med ( ) High ( )

Shine (✓) None ( ) Dull ( ) Gloss ( ) H. Gloss ( )

Shake Test ( ) None ( ) Slow (✓) Fast ( ) Rapid ( )

Torvane: .42 TSF

Color: Yellowish brown

Disturbance:

Est. Max. Particle Size:

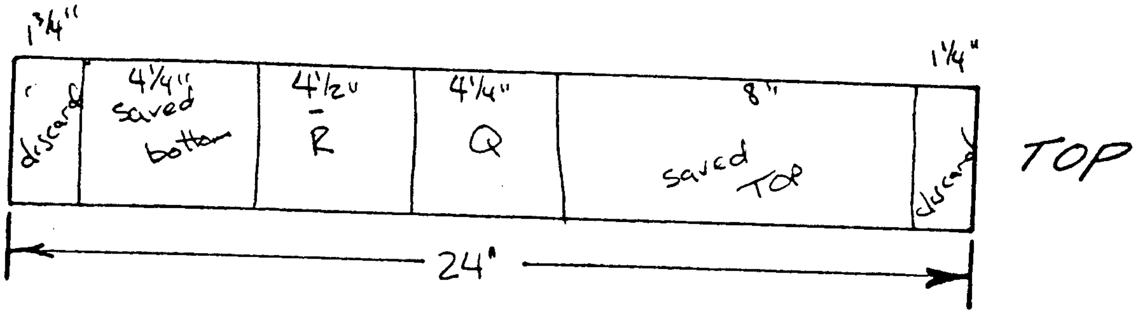
Remarks:

Odor: None

Cementation: reactive to HCl

Date Core Opened: 2/22/93

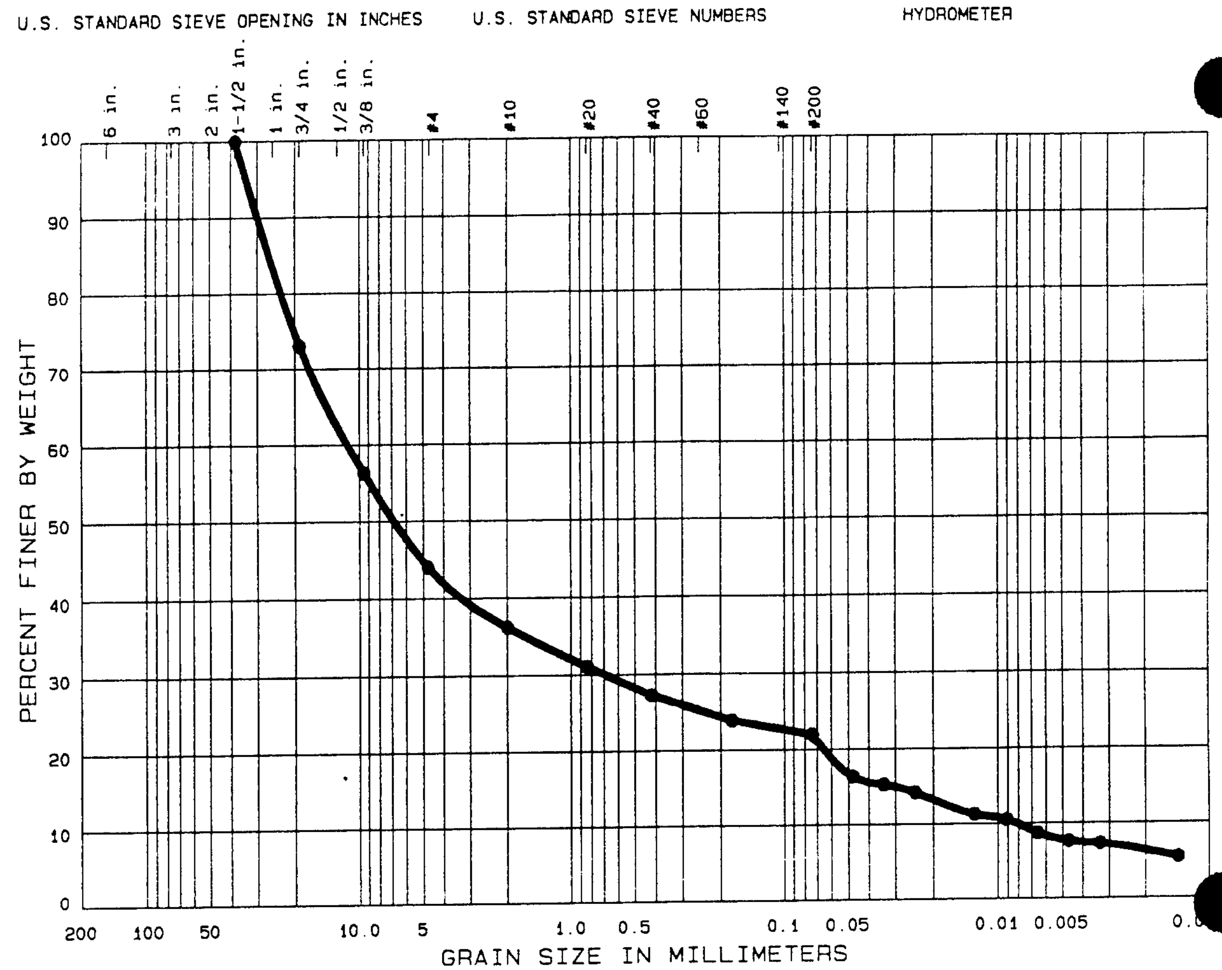
Sketch: (Core description and specimen location)



Technician MJW

Figure 30

W.O. No. CH92197W1
Req. No. CENCS-IA-93-30-ED-GH
Contract No.



% COBBLES		% GRAVEL	% SAND	% SILT OR CLAY	
●	0.0	55.9	22.1	14.3	7.7

	Sample No.	Elev or Depth	Nat W%	LL	PL	PI	C_c	C_u
●	W-1	4.0'-4.6'	26.5	62	27	35	4.84	1396.4

CLASSIFICATION

● CLAYEY SANDY GRAVEL, GC
SPECIFIC GRAVITY = 2.62

Remarks:

Project CHASKA FLOOD CONTROL
EAST CREEK, STAGE 3
Lab No. 1897
Area
Boring No. 92-197MU   Date 02/25/93

GRADATION CURVES

CORPS OF ENGINEERS, MISSOURI RIVER DIVISION LAB
420 SOUTH 18th STREET - OMAHA, NE 68102-2586

Figure 31 FIG D-3

CLASSIFICATION TEST REQUEST

PROJECT: Chaska Flood Control

ACCOMPANYING TEST: Q

CONTAINER - TYPE: 5" Wax

SAMPLE IDENTIFICATION: 92-197MU W-1 40'-46'

MRD LAB. NO.: 1897

REQUEST NO. CEMCS-IA-93-30-ED-GH

NO.: -

SAMPLE IDENTIFICATION:

Structure: ( ) Brittle (✓) Plastic ( )

Consistency: Undisturbed ( ) Soft (✓) Med ( ) Stiff ( ) Hard

Remolded (✓) Insensitive ( ) Sl. Sens. ( ) Sensitive

PL Thread: Strength ( ) Low ( ) Med (✓) High ( )

Shine ( ) None (✓) Dull ( ) Gloss ( ) H. Gloss ( )

Shake Test (✓) None ( ) Slow ( ) Fast ( ) Rapid ( )

Torvane: None taken, too rocky

Color: dark brown

Disturbance: rocks

Est. Max. Particle Size: 3"

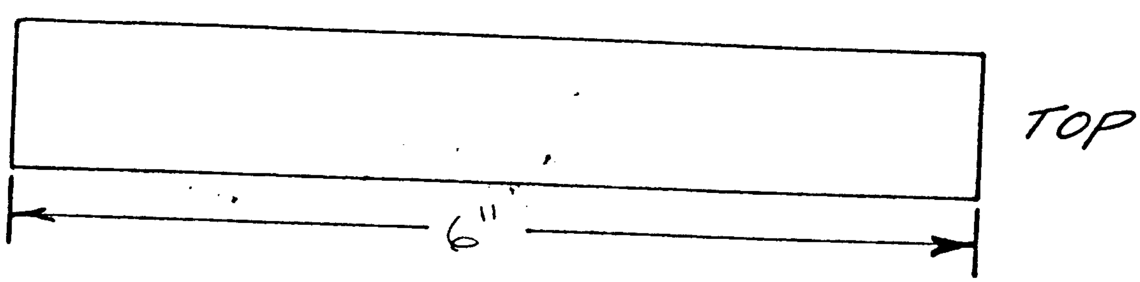
Remarks: sample was all rocks, couldn't get any Q specimens

Odor: none

Cementation: reactive to HCl

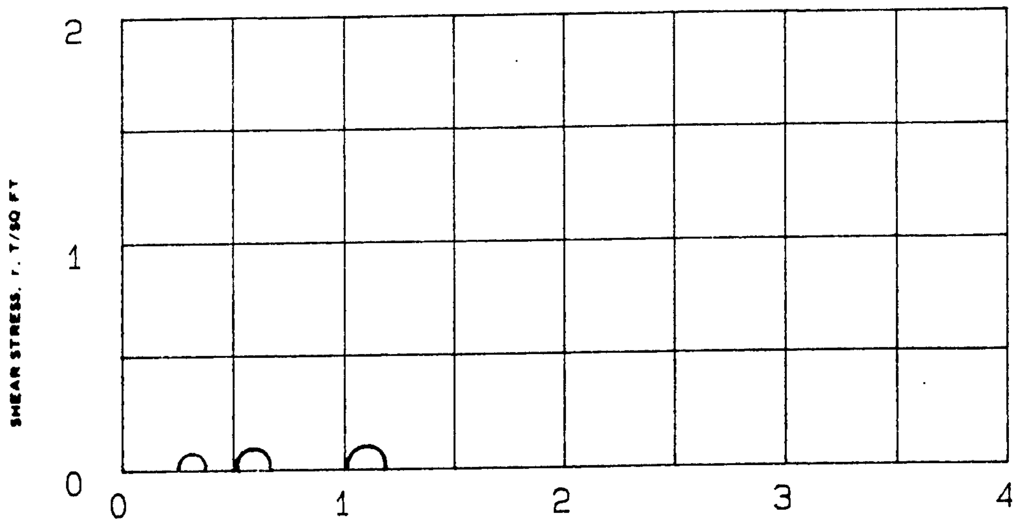
Date Core Opened: 2/23/93

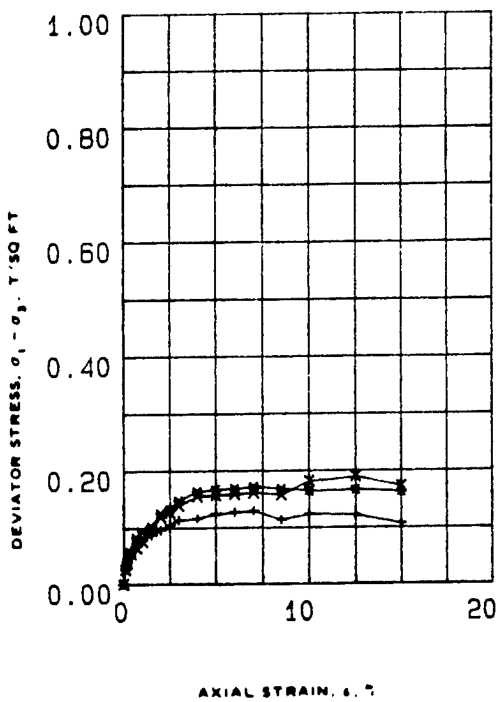
Sketch: (Core description and specimen location)



Technician MJW

Figure 32
FIGURE D-347





			1 (+)	2 (*)	3 (X)
SPECIMEN NO.			1 (+)	2 (*)	3 (X)
INITIAL	WATER CONTENT, %	w_o	102.5	109.8	97.3
	DRY DENSITY LB/CU FT	γd_o	43.3	40.9	45.0
	SATURATION, %	S_o	99.0	98.0	99.0
	VOID RATIO	e_o	2.53	2.74	2.40
BEFORE SHEAR	WATER CONTENT, %	w_c	101.7	105.1	96.2
	DRY DENSITY LB/CU FT	γd_c	43.4	40.9	45.1
	SATURATION, %	S_c	99.0	94.0	99.0
	VOID RATIO	e_c	2.53	2.74	2.39
	FINAL BACK PRESSURE, T/SQ FT	u_o	0.0	0.0	0.0
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	0.3	0.5	1.0
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	0.13	0.17	0.19
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	12.5	13.5	25.3
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	0.11	0.16	0.17
INITIAL DIAMETER, IN.		D_o	1.40	1.39	1.42
INITIAL HEIGHT, IN.		H_o	2.98	2.98	2.96

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Slightly Organic Sandy Silt, MH

LL 78	PL 51	PI 27	Gs 2.45	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST Q

REMARKS Yellowish gray/black.
Torvane=0.35 TSF. Calcareous.

PROJECT CHASKA FLOOD CONTROL; CEMCS-IA-93-30-ED-G

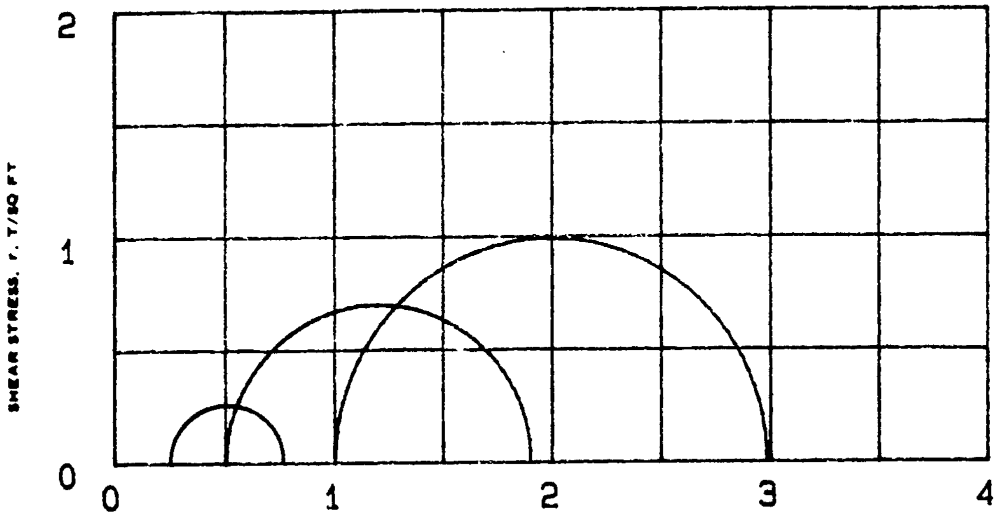
BORING NO 92-198MU — SAMPLE NO. W-1

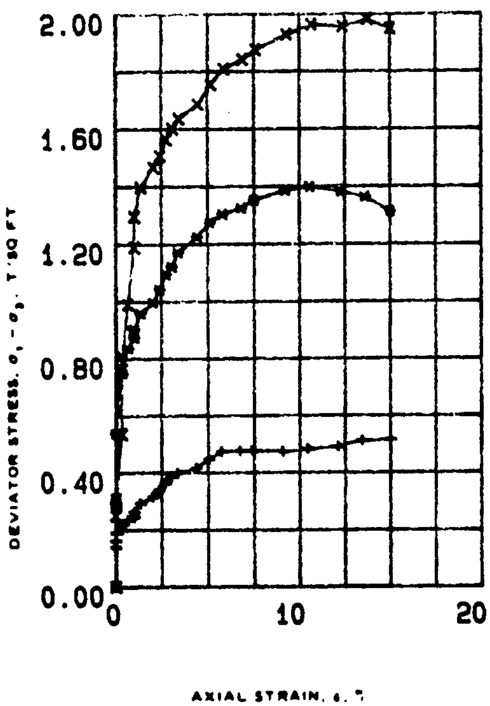
DEPTH ELEV 3.0'-4.2'

LABORATORY 1897 — DATE 2-25-93

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO 2089 REV JUNE 1970 — PREVIOUS EDITION IS OBSOLETE — TRANSLUCENT — (EM 1110-2-1906) — FIGURE 1





SPECIMEN NO.			1 (+)	2 (✻)	3 (X)
INITIAL	WATER CONTENT, %	w_o	76.8	79	80.1
	DRY DENSITY LB/CU FT	γ_{d_o}	55.9	50.6	51
	SATURATION, %	S_o	100	96	98
	VOID RATIO	e_o	1.74	2.03	2
BEFORE SHEAR	WATER CONTENT, %	w_c	77	80.8	77.7
	DRY DENSITY LB/CU FT	γ_{d_c}	56	52.3	54
	SATURATION, %	S_c	100	100	100
	VOID RATIO	e_c	1.73	1.93	1.83
	FINAL BACK PRESSURE, T/SQ FT	u_o	4.103	4.103	4.103
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.25	.5	1
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	0.514	1.399	1.981
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	1550	1200	1440
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	0.514	1.311	1.948
INITIAL DIAMETER, IN.		D_o	1.4	1.4	1.4
INITIAL HEIGHT, IN.		H_o	2.98	2.97	2.97
B-Value			1.0	1.0	1.0

CONTROLLED-STRAIN TEST

Description of Specimens: Slightly Organic Sandy Silt, MH

LL 78	PL 51	PI 27	G_s 2.45

TYPE OF SPECIMEN UNDISTURBED

TYPE OF TEST R̄BAR

REMARKS: Yellowish gray/black.

Torvane=0.35 TSF. Calcareous.

PROJECT CHASKA FLOOD C.P.; IA-93-30

BORING NO 92-198

SAMPLE NO. W-1

DEPTH ELEV 3-4.2

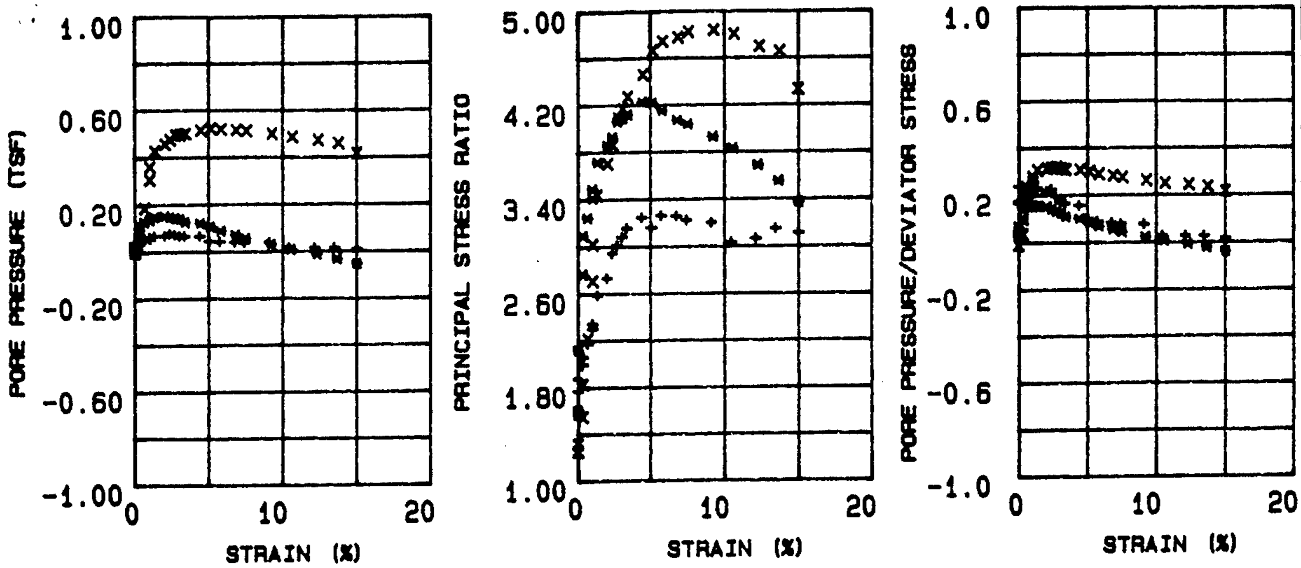
LABORATORY 1897

DATE 3-1-93

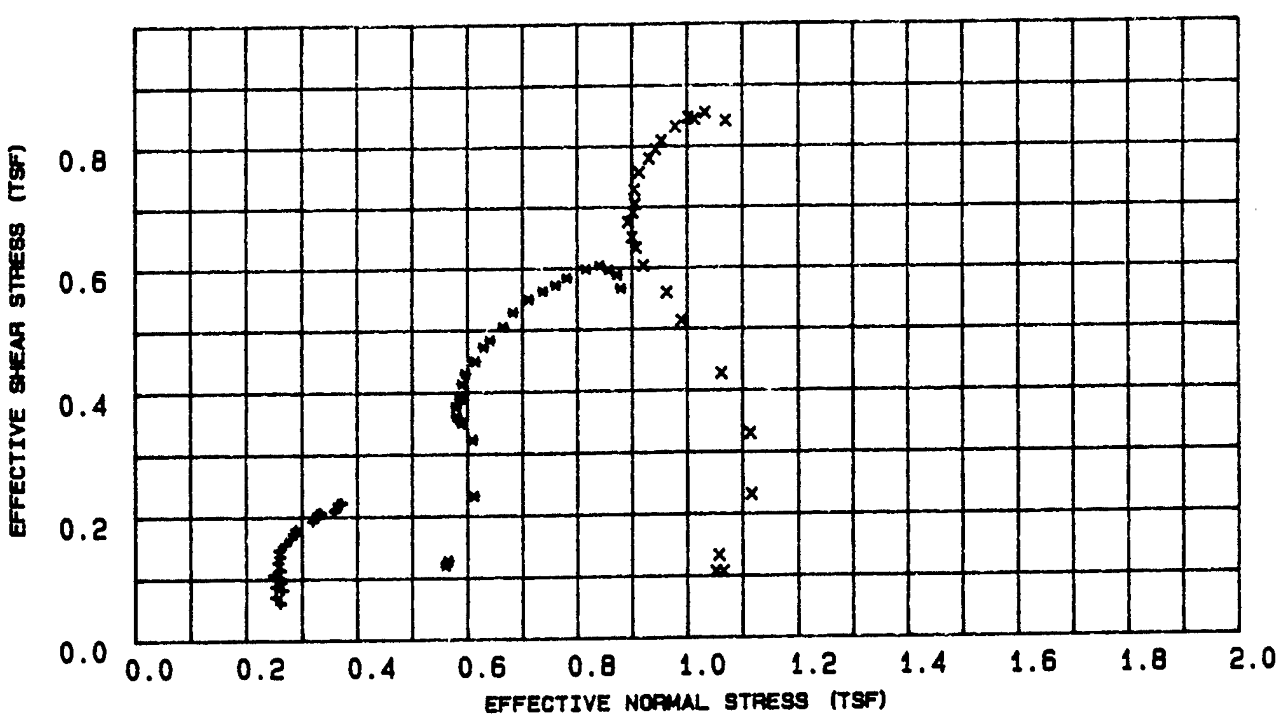
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

FIGURE 2



EFFECTIVE STRESS VECTOR CURVES ON 60 DEGREE PLANE



LEGEND

+ = .25 TSF
* = .5 TSF
X = 1 TSF

PROJECT	CHASKA FLOOD C.P.; IA-93-30
BORING NO.	92-198
SAMPLE NO.	W-1
DEPTH/ELEV	3-4.2
MRD LAB NO.	1897

FIGURE 3

R

Table 1 - Triaxial $\overline{R}$ Test Results

Project : CHASKA FLOOD C.P.;IA-93-30
Boring Number : 92-198
Sample Number : W-1
Depth : 3-4.2
Confining Pressure : .25 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.00	0.139	0.023	1.612	0.166	0.261	0.060
30	0.00	0.162	0.038	1.766	0.236	0.252	0.070
45	0.00	0.190	0.032	1.875	0.171	0.265	0.082
60	0.34	0.201	0.048	1.992	0.237	0.252	0.087
90	0.34	0.219	0.042	2.058	0.194	0.262	0.095
120	0.67	0.234	0.050	2.174	0.216	0.258	0.101
150	1.01	0.245	0.062	2.300	0.254	0.249	0.106
180	1.01	0.263	0.054	2.342	0.206	0.261	0.114
210	1.35	0.292	0.066	2.586	0.228	0.256	0.126
240	2.02	0.316	0.068	2.731	0.215	0.260	0.136
300	2.35	0.339	0.076	2.943	0.224	0.258	0.146
360	2.69	0.362	0.070	3.010	0.193	0.270	0.156
420	3.03	0.385	0.065	3.080	0.169	0.280	0.166
480	3.36	0.399	0.065	3.154	0.163	0.284	0.172
540	4.37	0.417	0.064	3.243	0.154	0.289	0.180
600	5.05	0.448	0.042	3.159	0.095	0.319	0.193
720	5.72	0.474	0.040	3.260	0.086	0.327	0.205
840	6.73	0.477	0.038	3.253	0.080	0.330	0.206
960	7.40	0.476	0.035	3.218	0.075	0.333	0.206
1080	9.08	0.473	0.035	3.198	0.073	0.332	0.204
1200	10.43	0.483	0.012	3.026	0.024	0.358	0.209
1320	12.11	0.491	0.012	3.061	0.024	0.360	0.212
1440	13.45	0.512	0.012	3.146	0.023	0.365	0.221
1550	15.00	0.514	0.006	3.107	0.013	0.371	0.222

Table 2 - Triaxial $\overline{R}$ Test Results

Project : CHASKA FLOOD C.P.;IA-93-30
Boring Number : 92-198
Sample Number : W-1
Depth : 3-4.2
Confining Pressure : .5 TSF

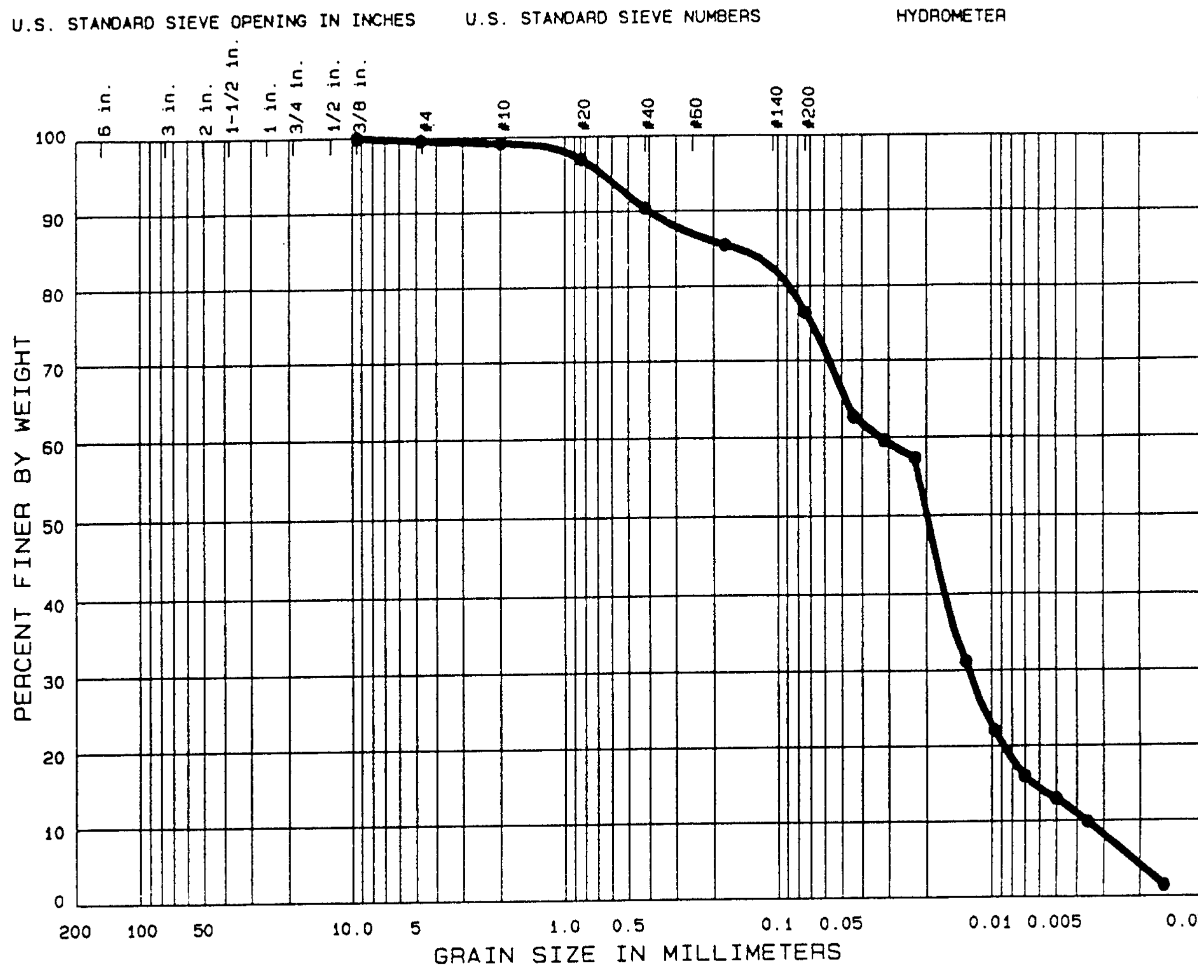
Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.00	0.278	0.009	1.565	0.032	0.560	0.120
30	0.00	0.297	0.009	1.604	0.030	0.565	0.128
45	0.00	0.537	0.021	2.121	0.039	0.612	0.232
60	0.34	0.748	0.076	2.765	0.103	0.609	0.323
90	0.34	0.810	0.113	3.093	0.140	0.588	0.350
120	0.68	0.837	0.127	3.243	0.152	0.580	0.361
150	1.02	0.874	0.137	3.407	0.157	0.579	0.377
180	1.02	0.903	0.137	3.485	0.152	0.586	0.390
210	1.36	0.958	0.147	3.713	0.154	0.590	0.413
240	2.04	0.997	0.151	3.858	0.152	0.596	0.430
300	2.39	1.042	0.144	3.926	0.139	0.614	0.450
360	2.73	1.096	0.142	4.059	0.130	0.629	0.473
420	3.07	1.121	0.137	4.087	0.123	0.641	0.484
480	3.41	1.170	0.125	4.121	0.108	0.665	0.505
540	4.43	1.226	0.120	4.227	0.099	0.683	0.529
600	5.11	1.274	0.104	4.215	0.082	0.711	0.550
720	5.79	1.304	0.086	4.147	0.066	0.737	0.563
840	6.81	1.325	0.068	4.069	0.052	0.760	0.572
960	7.50	1.353	0.054	4.033	0.040	0.781	0.584
1080	9.20	1.386	0.027	3.927	0.020	0.816	0.598
1200	10.56	1.399	0.005	3.826	0.004	0.841	0.604
1320	12.27	1.381	-0.015	3.680	-0.010	0.857	0.596
1440	13.63	1.362	-0.035	3.545	-0.025	0.872	0.588
1536	15.00	1.311	-0.055	3.363	-0.042	0.879	0.566

Table 3 - Triaxial $\bar{R}$ Test Results

Project : CHASKA FLOOD C.P.;IA-93-30
Boring Number : 92-198
Sample Number : W-1
Depth : 3-4.2
Confining Pressure : 1 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.00	0.249	-0.003	1.248	-0.011	1.065	0.107
30	0.00	0.249	0.011	1.251	0.044	1.051	0.107
45	0.00	0.307	0.019	1.313	0.064	1.057	0.133
60	0.34	0.535	0.017	1.545	0.033	1.116	0.231
90	0.34	0.763	0.075	1.825	0.099	1.114	0.329
120	0.69	0.989	0.184	2.213	0.187	1.061	0.427
150	1.03	1.189	0.304	2.708	0.256	0.990	0.513
180	1.03	1.295	0.358	3.017	0.277	0.963	0.559
210	1.37	1.398	0.426	3.433	0.305	0.920	0.603
240	2.06	1.467	0.456	3.699	0.312	0.907	0.633
300	2.40	1.506	0.474	3.861	0.315	0.899	0.650
360	2.75	1.563	0.495	4.093	0.317	0.892	0.675
420	3.09	1.601	0.495	4.173	0.310	0.901	0.691
480	3.44	1.635	0.500	4.272	0.307	0.905	0.705
540	4.47	1.686	0.513	4.459	0.305	0.904	0.728
600	5.15	1.754	0.521	4.665	0.298	0.913	0.757
720	5.84	1.808	0.517	4.743	0.286	0.931	0.780
840	6.87	1.841	0.513	4.778	0.279	0.943	0.795
960	7.56	1.875	0.510	4.824	0.272	0.954	0.809
1080	9.28	1.928	0.498	4.838	0.259	0.979	0.832
1200	10.65	1.963	0.484	4.803	0.247	1.002	0.847
1320	12.37	1.955	0.471	4.694	0.241	1.013	0.844
1440	13.74	1.981	0.458	4.654	0.232	1.032	0.855
1527	15.00	1.948	0.413	4.328	0.212	1.069	0.841

W.O. No. ch198w1
Req. No. CENCS-IA-93-30-ED-GH
Contract No.



% COBBLES		% GRAVEL	% SAND	% SILT OR CLAY	
●	0.0	0.4	23.2	63.5	12.9

	Sample No.	Elev or Depth	Nat W%	LL	PL	PI	C_c	C_u
●	W-1	3.0'-4.2'		78	51	27	1.35	9.1

CLASSIFICATION

● Slightly organic Sandy Silt, MH
Specific gravity = 2.45

Remarks:	Project CHASKA FLOOD CONTROL EAST CREEK, STAGE 3 Lab No. 1897 Area Boring No. 92-198 MU Date 2/25/93

GRADATION CURVES

CORPS OF ENGINEERS, MISSOURI RIVER DIVISION LAB
420 SOUTH 18th STREET - OMAHA, NE 68102-2586

Figure 4 FIGURE D-354

CLASSIFICATION TEST REQUEST

PROJECT: Chaska Flood Control

ACCOMPANYING TEST: Q, R

CONTAINER - TYPE: 5" Wax

SAMPLE IDENTIFICATION: 92-198MU W-1 30-42'

MRD LAB. NO.: 1897

REQUEST NO. CENCS-IA-93-30-ED-GH

NO.:

SAMPLE IDENTIFICATION:

Structure: ( ) Brittle ( ) Plastic ( )

Consistency: Undisturbed ( ) Soft ( ) Med ( ) Stiff ( ) Hard

Remolded ( ) Insensitive ( ) Sl. Sens. ( ) Sensitive

PL Thread: Strength ( ) Low ( ) Med ( ) High ( )

Shine ( ) None ( ) Dull ( ) Gloss ( ) H. Gloss ( )

Shake Test ( ) None ( ) Slow ( ) Fast ( ) Rapid ( )

Torvane: .35 TSF

Color: yellowish grey/black

Disturbance: rocks, wire, roots.

Est. Max. Particle Size: 1"

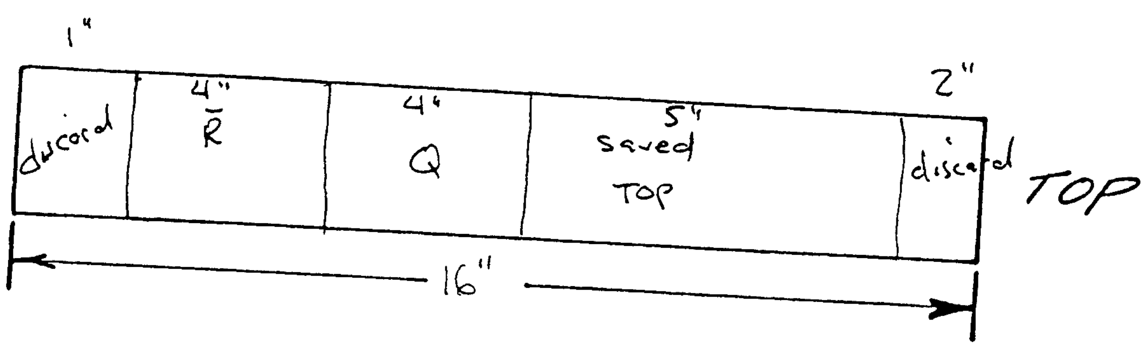
Remarks: sample was layered with clay, ~~and~~ silt, and debris.

Odor: none

Cementation: reactive to HCl

Date Core Opened: 2/23/93

Sketch: (Core description and specimen location)



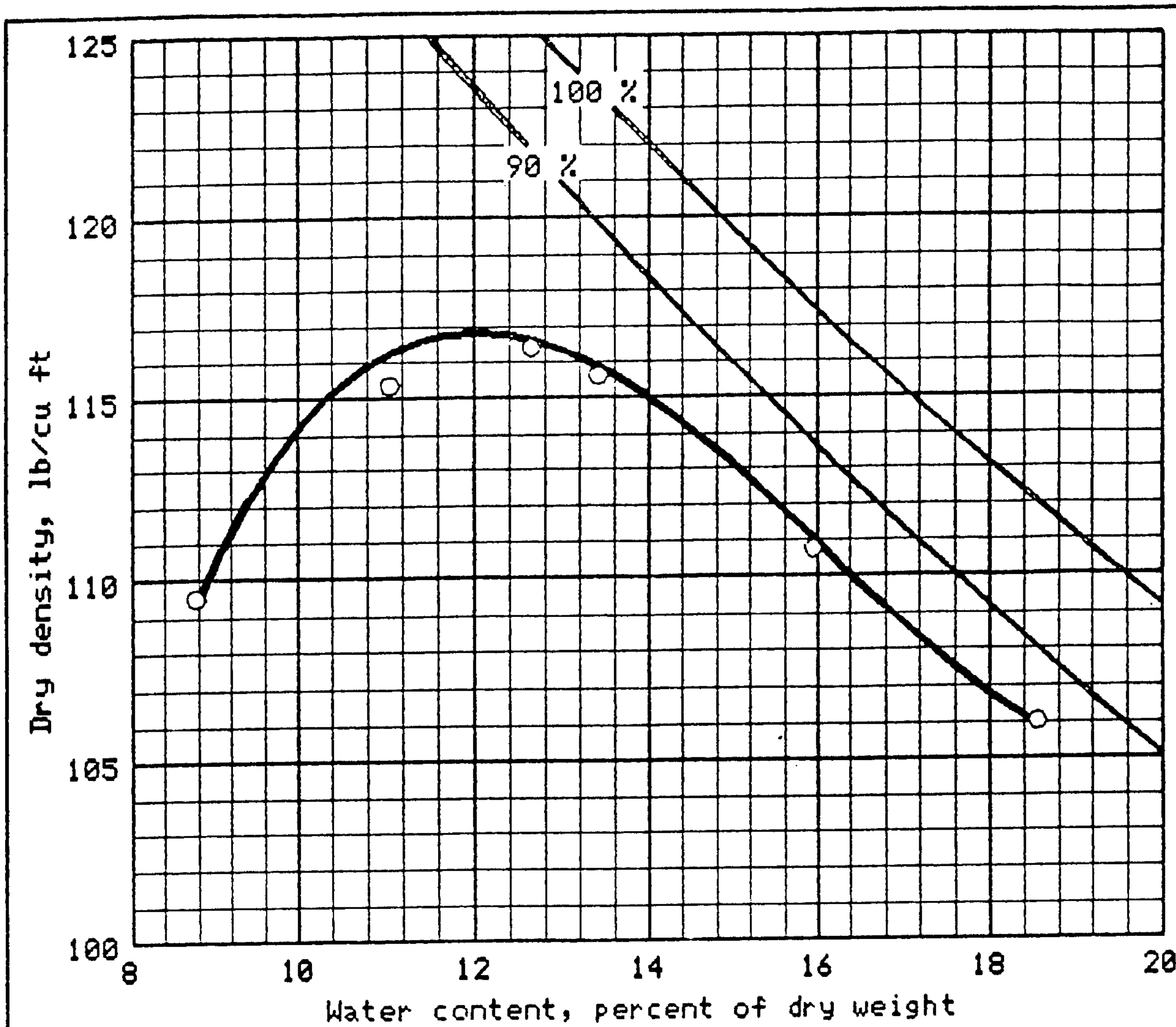
Technician MJW

Figure 5

FIGURE D-355

WORK ORDER NO. 93-30-ED-GH
Req. No. CENCS-IA-93-30-ED-GH
Contract No. NA

CORPS OF ENGINEERS, MISSOURI RIVER DIVISION LAB
420 SOUTH 18th STREET - OMAHA, NE 68102-2586



Standard compaction test EM-1110-2-1906
25 blows per each of 3 layers, with 5.50 lb. sl. weight rammer and 12.0 inch drop. 4.0 inch diameter mold

Sample No.	Elev/ Depth	Classification	G	LL	PL	% > No.4	% > 3/4 in.
1	1.5'-	CLAYEY SAND SC	2.69	35	14	0.7	0
	10.0'						

Sample No.	1			
Water content, percent	3.0	Air dried		
Optimum water content, percent	12.0			
Max dry density, lb/cu ft	116.8			

Remarks:

Project: CHASKA FLOOD CONTROL, EAST CREEK
STAGE # 3

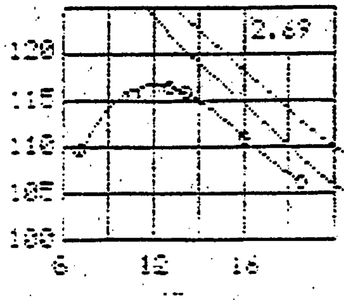
Lab No.: 1897

Area:

Boring No.: 92M-199 | Date: 2-9-93

COMPACTION TEST REPORT

Figure # 1 FIGURE D-356



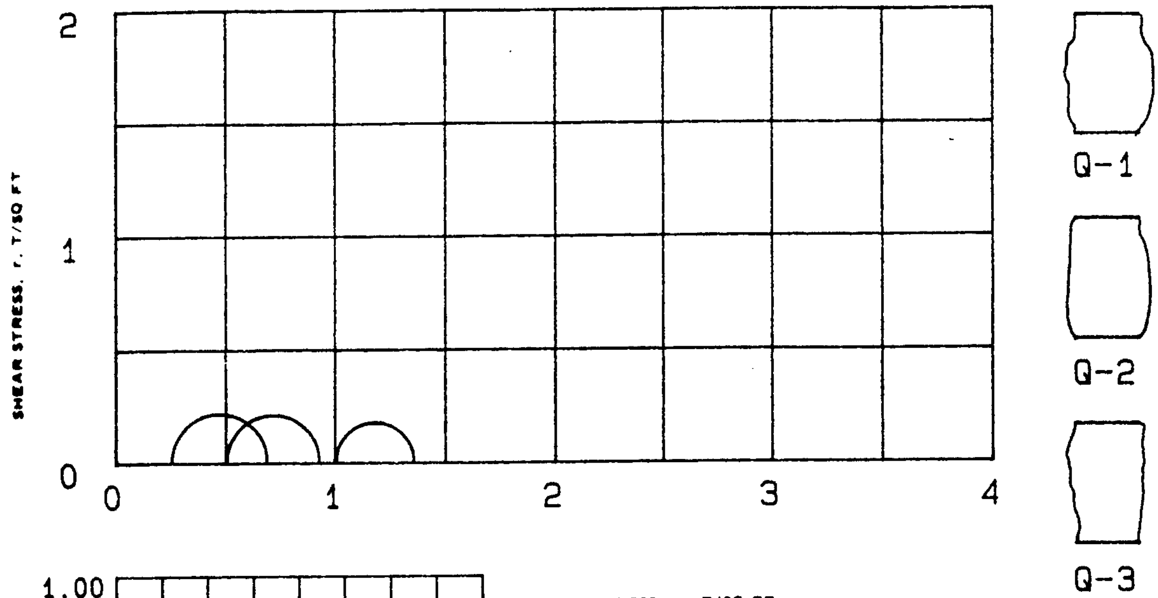
Project: CHASKA FLOOD CONTROL, EAST CREEK

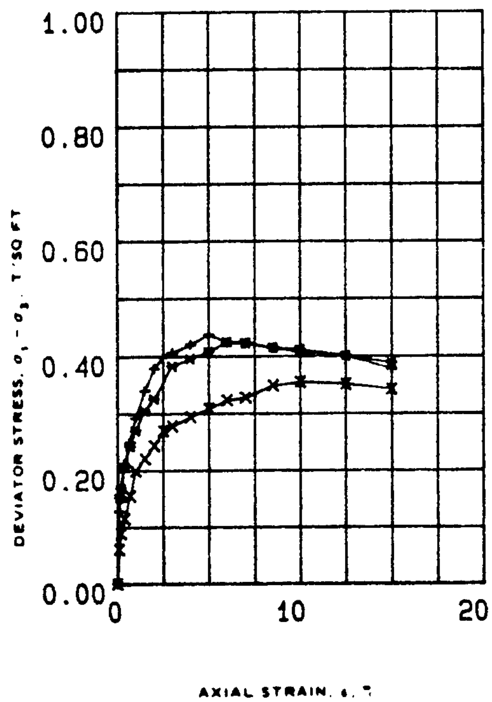
Lab No.: 1997 Boring No.: 92M-199

POINT NO.	1	2	3	4	5	6
WM + WS	8.70	8.60	8.61	8.52	8.30	8.70
WM	4.33	4.33	4.33	4.33	4.33	4.33
WM+T #1	2042.80	2053.50	2061.50	2062.40	2091.50	1979.20
WD+T #1	1855.10	1894.50	1851.30	1822.50	1965.70	1823.20
WT #1	455.10	456.00	533.00	529.50	530.70	589.50
MOIST #1	13.4	11.1	15.9	18.6	8.8	12.6
MOISTURE	13.4	11.1	15.9	18.6	8.8	12.6
DRY DEN	115.6	115.4	110.8	106.0	109.5	116.4

Max dry den= 116.8 pcf Opt moisture= 12.0 %

Figure # 1a FIGURE D-357





				1 (+)	2 (*)	3 (X)	
SPECIMEN NO.							
INITIAL	WATER CONTENT, %		w_o	42.8	43.2	41.1	
	DRY DENSITY LB/CU FT		γ_{d_o}	76.2	76.2	73.8	
	SATURATION, %		S_o	93.0	94.0	84.0	
	VOID RATIO		e_o	1.28	1.28	1.35	
BEFORE SHEAR	WATER CONTENT, %		w_c	41.2	41.2	41.6	
	DRY DENSITY LB/CU FT		γ_{d_c}	76.2	76.2	73.6	
	SATURATION, %		S_c	90.0	90.0	85.0	
	VOID RATIO		e_c	1.28	1.28	1.36	
	FINAL BACK PRESSURE, T/SQ FT		u_o	0.0	0.0	0.0	
MINOR PRINCIPAL STRESS, T/SQ FT			σ_3	0.3	0.5	1.0	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$		0.44	0.42	0.36	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN			t_f	9.5	13.0	19.0	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$		0.38	0.39	0.34	
INITIAL DIAMETER, IN			D_o	1.41	1.43	1.39	
INITIAL HEIGHT, IN			H_o	2.98	3.00	2.99	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Clayey Sand, SC

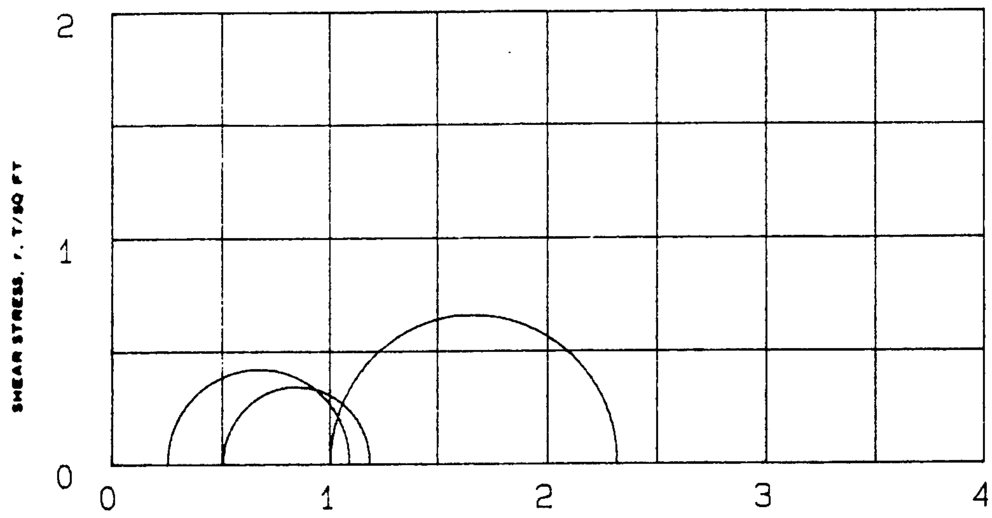
LL 46	PL 19	PI 27	G_s 2.78	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST Q

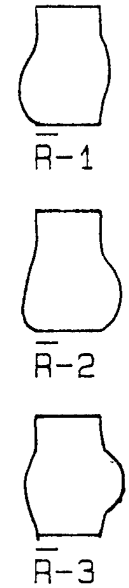
REMARKS Black. Torvane=0.3 TSF.
Slightly calcareous.

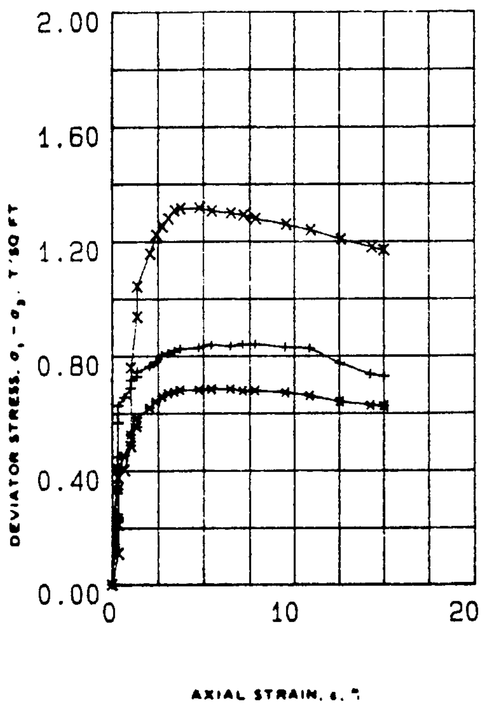
PROJECT	CHASKA FLOOD CONTROL; CONCS-IA-93-30-ED-8
BORING NO 92-200MU1	SAMPLE NO. W-1
DEPTH ELEV 3.0'-5.0'	
LABORATORY 1897	DATE 2/8/93

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906) FIGURE 11







			SPECIMEN NO.	1 (+)	2 (✱)	3 (X)	
INITIAL	WATER CONTENT, %	w_o	32.8	34.1	35.7	
	DRY DENSITY LB/CU FT	γ_{d_o}	85.1	81.8	81.1	
	SATURATION, %	S_o	88	84	87	
	VOID RATIO	e_o	1.04	1.12	1.14	
BEFORE SHEAR	WATER CONTENT, %	w_c	33.4	36.7	36.1	
	DRY DENSITY LB/CU FT	γ_{d_c}	88.2	85.2	85.9	
	SATURATION, %	S_c	96	98	98	
	VOID RATIO	e_c	.97	1.04	1.02	
	FINAL BACK PRESSURE, T/SQ FT	u_o	4.823	4.823	4.823	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.25	.5	1	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	0.840	0.684	1.317	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	960	720	540	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	0.728	0.624	1.169	
INITIAL DIAMETER, IN.		D_o	1.41	1.44	1.43	
INITIAL HEIGHT, IN.		H_o	2.99	2.99	2.99	
B-Value			1.0	1.0	1.0	

CONTROLLED- STRAIN TEST

Description of Specimens: Clayey Sand, SC

LL	PL	PI	G_s	TYPE OF SPECIMEN	TYPE OF TEST
46	19	27	2.78	UNDISTURBED	RBAR

REMARKS: Black. Torvane=0.3 TSF.
Slightly calcareous.

PROJECT: CHASKA FLOOD C.P.; IA-93-30

BORING NO: 92-200 MU1 — SAMPLE NO.: W-1

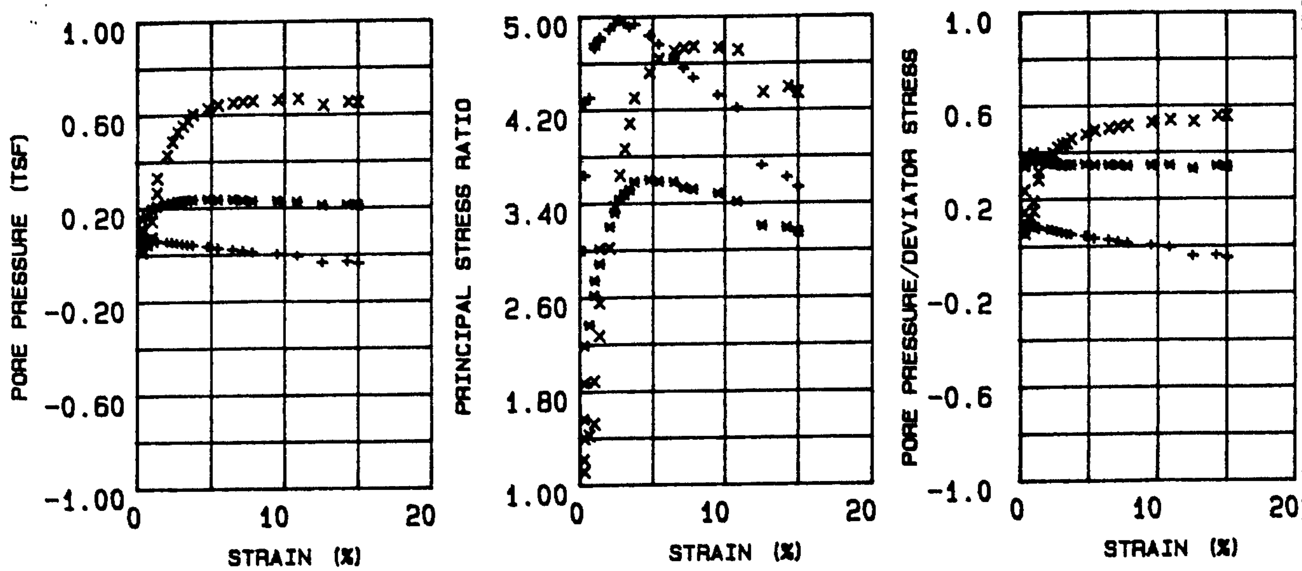
DEPTH ELEV: 3'-5'

LABORATORY: 1897 — DATE: 3-2-93

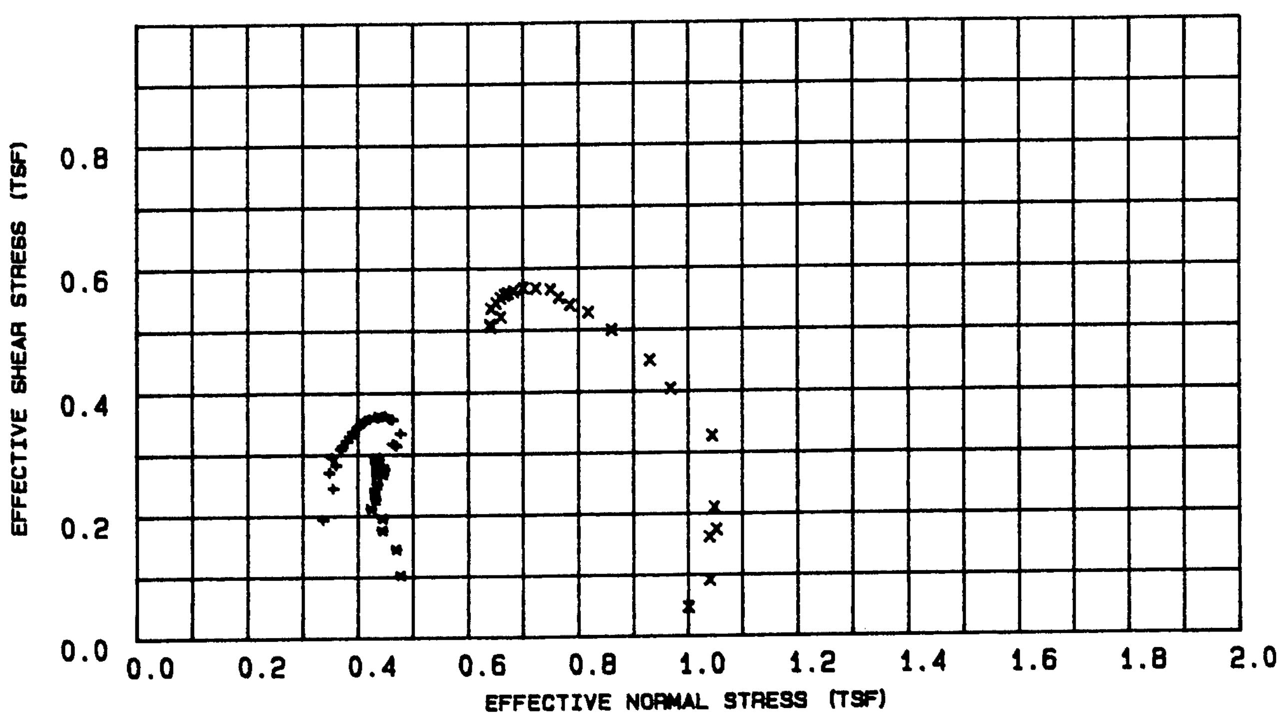
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO 2089 — REV JUNE 1970 — PREVIOUS EDITION IS OBSOLETE — TRANSLUCENT — *(EM 1110-2-1906)*

FIGURE 12



EFFECTIVE STRESS VECTOR CURVES ON 60 DEGREE PLANE



LEGEND

+ = .25 TSF

✱ = .5 TSF

X = 1 TSF

PROJECT	CHASKA FLOOD C.P.: IA-93-30
BORING NO.	92-200 MU1
SAMPLE NO.	W-1
DEPTH/ELEV	3'-5'
MRD LAB NO.	1897

FIGURE 13

R

Table 4 - Triaxial $\bar{R}$ Test Results

Project : CHASKA FLOOD C.P.; IA-93-30
Boring Number : 92-200 MU1
Sample Number : W-1
Depth : 3'-5'
Confining Pressure : .25 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.34	0.449	0.025	2.999	0.057	0.336	0.194
30	0.34	0.567	0.035	3.639	0.063	0.355	0.245
45	0.34	0.627	0.058	4.261	0.092	0.347	0.271
60	0.68	0.655	0.052	4.305	0.080	0.360	0.283
90	1.02	0.687	0.068	4.768	0.099	0.352	0.296
120	1.02	0.715	0.058	4.729	0.082	0.369	0.309
150	1.36	0.728	0.058	4.798	0.081	0.372	0.314
180	1.36	0.746	0.055	4.822	0.074	0.380	0.322
210	2.03	0.763	0.054	4.892	0.071	0.385	0.329
240	2.37	0.780	0.052	4.937	0.067	0.391	0.337
300	2.71	0.802	0.048	4.974	0.061	0.401	0.346
360	3.05	0.810	0.045	4.942	0.056	0.405	0.349
420	3.39	0.817	0.041	4.911	0.051	0.411	0.353
480	3.73	0.825	0.040	4.934	0.049	0.414	0.356
540	4.75	0.829	0.034	4.837	0.041	0.421	0.358
600	5.42	0.839	0.027	4.759	0.032	0.431	0.362
720	6.44	0.834	0.020	4.630	0.025	0.437	0.360
840	7.12	0.840	0.014	4.553	0.017	0.444	0.362
960	7.80	0.840	0.008	4.471	0.010	0.450	0.363
1080	9.49	0.830	0.000	4.321	0.001	0.456	0.358
1200	10.85	0.826	-0.007	4.212	-0.008	0.462	0.357
1320	12.54	0.774	-0.035	3.720	-0.044	0.477	0.334
1440	14.24	0.735	-0.031	3.616	-0.042	0.463	0.317
1507	15.00	0.728	-0.038	3.530	-0.052	0.468	0.314
1507	15.00	0.728	-0.038	3.530	-0.052	0.468	0.314

Table 5 - Triaxial $\bar{R}$ Test Results

Project : CHASKA FLOOD C.P.; IA-93-30
Boring Number : 92-200 MU1
Sample Number : W-1
Depth : 3'-5'
Confining Pressure : .5 TSF

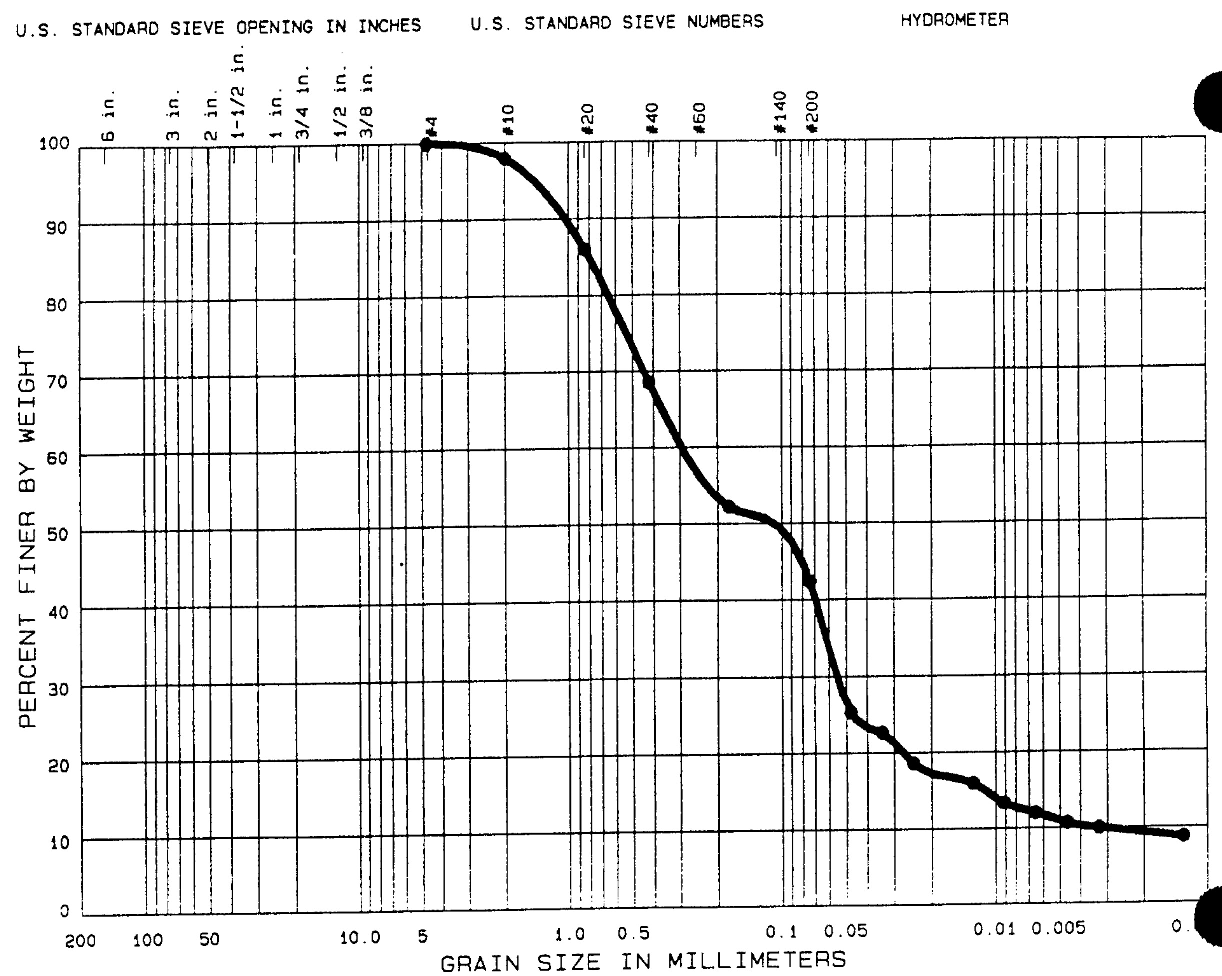
Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.34	0.236	0.081	1.563	0.346	0.477	0.102
30	0.34	0.336	0.114	1.871	0.341	0.469	0.145
45	0.34	0.409	0.157	2.192	0.384	0.444	0.176
60	0.68	0.454	0.168	2.367	0.370	0.444	0.196
90	1.02	0.490	0.197	2.616	0.401	0.424	0.212
120	1.02	0.527	0.198	2.744	0.376	0.432	0.227
150	1.36	0.553	0.207	2.886	0.374	0.430	0.239
180	1.36	0.585	0.210	3.014	0.359	0.435	0.252
210	2.04	0.619	0.219	3.203	0.354	0.434	0.267
240	2.37	0.641	0.224	3.322	0.350	0.435	0.277
300	2.71	0.658	0.230	3.434	0.350	0.433	0.284
360	3.05	0.670	0.230	3.479	0.343	0.436	0.289
420	3.39	0.674	0.233	3.518	0.346	0.434	0.291
480	3.73	0.681	0.236	3.582	0.347	0.433	0.294
540	4.75	0.682	0.238	3.599	0.349	0.431	0.294
600	5.43	0.684	0.235	3.585	0.345	0.434	0.295
720	6.45	0.684	0.235	3.579	0.344	0.434	0.295
840	7.12	0.677	0.233	3.531	0.344	0.435	0.292
960	7.80	0.678	0.230	3.516	0.340	0.438	0.293
1080	9.50	0.671	0.230	3.481	0.343	0.436	0.289
1200	10.85	0.660	0.226	3.409	0.343	0.437	0.285
1320	12.55	0.639	0.210	3.200	0.328	0.448	0.276
1440	14.25	0.626	0.213	3.182	0.341	0.442	0.270
1506	15.00	0.624	0.210	3.148	0.337	0.445	0.269
1506	15.00	0.624	0.210	3.148	0.337	0.445	0.269

Table 6 - Triaxial $\bar{R}$ Test Results

Project : CHASKA FLOOD C.P.; IA-93-30
Boring Number : 92-200 MU1
Sample Number : W-1
Depth : 3'-5'
Confining Pressure : 1 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.34	0.109	0.026	1.112	0.237	1.001	0.047
30	0.34	0.212	0.012	1.214	0.055	1.040	0.091
45	0.34	0.375	0.054	1.396	0.145	1.039	0.162
60	0.68	0.403	0.048	1.423	0.119	1.052	0.174
90	1.02	0.486	0.072	1.523	0.149	1.048	0.210
120	1.02	0.759	0.144	1.886	0.190	1.044	0.327
150	1.36	0.937	0.264	2.273	0.283	0.968	0.404
180	1.36	1.043	0.328	2.553	0.315	0.930	0.450
210	2.05	1.157	0.426	3.017	0.369	0.860	0.499
240	2.39	1.223	0.485	3.372	0.397	0.818	0.528
300	2.73	1.252	0.526	3.638	0.420	0.784	0.540
360	3.07	1.280	0.553	3.864	0.432	0.764	0.552
420	3.41	1.308	0.575	4.081	0.440	0.749	0.565
480	3.75	1.314	0.602	4.301	0.459	0.723	0.567
540	4.78	1.317	0.626	4.517	0.476	0.700	0.568
600	5.46	1.305	0.641	4.633	0.492	0.682	0.563
720	6.48	1.298	0.649	4.703	0.501	0.672	0.560
840	7.16	1.291	0.654	4.728	0.507	0.666	0.557
960	7.85	1.279	0.658	4.740	0.515	0.659	0.552
1080	9.55	1.259	0.662	4.730	0.527	0.650	0.544
1200	10.92	1.239	0.666	4.710	0.538	0.641	0.535
1320	12.62	1.206	0.639	4.345	0.531	0.660	0.521
1440	14.33	1.178	0.652	4.387	0.554	0.640	0.508
1498	15.00	1.169	0.650	4.343	0.556	0.640	0.505
1498	15.00	1.169	0.650	4.343	0.556	0.640	0.505

W.O. No. ch92200w1
Req. No. CENCS-IA-93-30-ED-GH
Contract No.



	% COBBLES	% GRAVEL	% SAND	% SILT OR CLAY	
●	0.0	0.0	57.6	31.5	10.9

	Sample No.	Elev or Depth	Nat W%	LL	PL	PI	C_c	C_u
●	W-1	3.0'-5.0'		46	19	27	3.02	87.1

CLASSIFICATION

● Clayey Sand, SC
Specific Gravity = 2.78

Remarks:	Project CHASKA FLOOD CONTROL EAST CREEK, STAGE 3 Lab No. 1897 Area Boring No. 92-200 MU1 Date 02/04/93

GRADATION CURVES

CORPS OF ENGINEERS, MISSOURI RIVER DIVISION LAB
420 SOUTH 18th STREET - OMAHA, NE 68102-2586

CLASSIFICATION TEST REQUEST

PROJECT: Chaska Flood Control

ACCOMPANYING TEST: Con, Q, $\bar{R}$

CONTAINER - TYPE: 5" Wax

SAMPLE IDENTIFICATION: 92-200MV2 W-1 30-50

MRD LAB. NO.:

REQUEST NO. CENCS-IA-93-30 ED-GH

NO.:

SAMPLE IDENTIFICATION:

Structure: ( ) Brittle (✓) Plastic ( )

Consistency: Undisturbed ( ) Soft (✓) Med ( ) Stiff ( ) Hard

Remolded ( ) Insensitive ( ) Sl. Sens. ( ) Sensitive

PL Thread: Strength ( ) Low ( ) Med (✓) High ( )

Shine ( ) None (X) Dull ( ) Gloss ( ) H. Gloss ( )

Shake Test (X) None ( ) Slow ( ) Fast ( ) Rapid ( )

Torvane: .3 TSF

Color: Black

Disturbance: Surface cracks

Est. Max. Particle Size: 1/4"

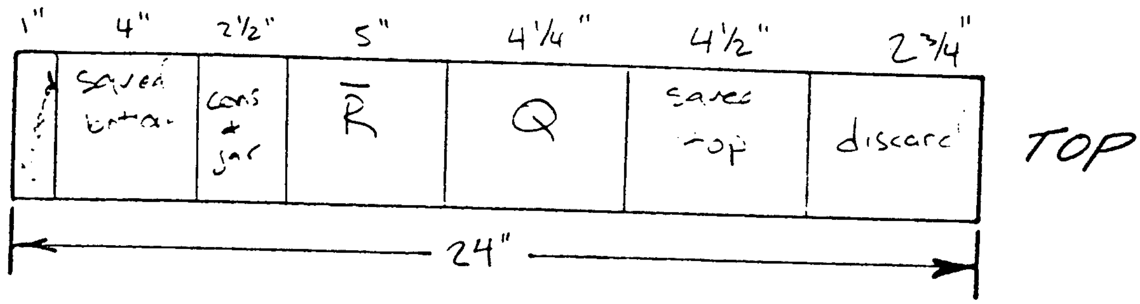
Remarks:

Odor: None

Cementation: slight reaction to HCl

Date Core Opened: 2/1/93

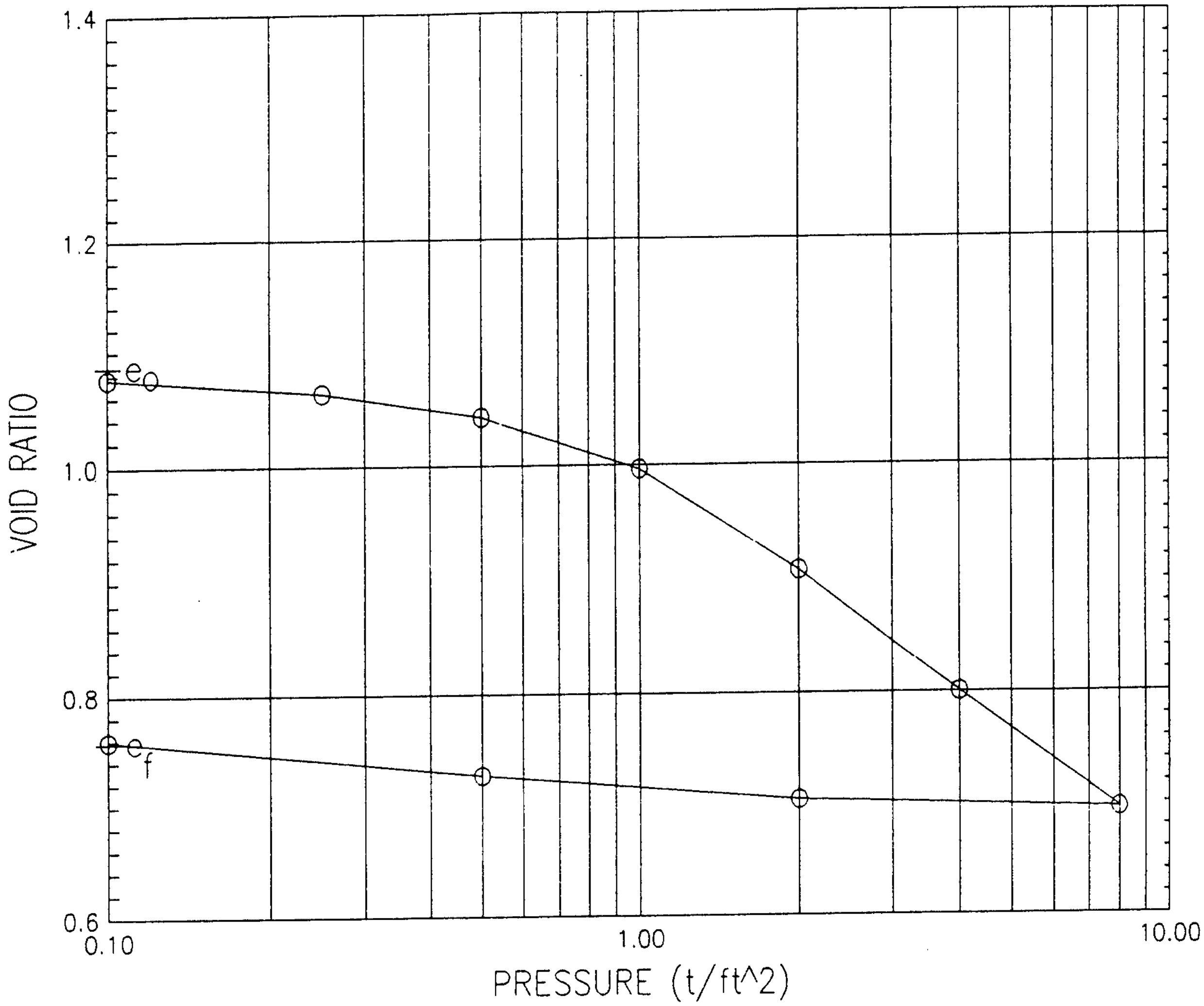
Sketch: (Core description and specimen location)



Technician MJW

Figure 15

FIGURE D-365

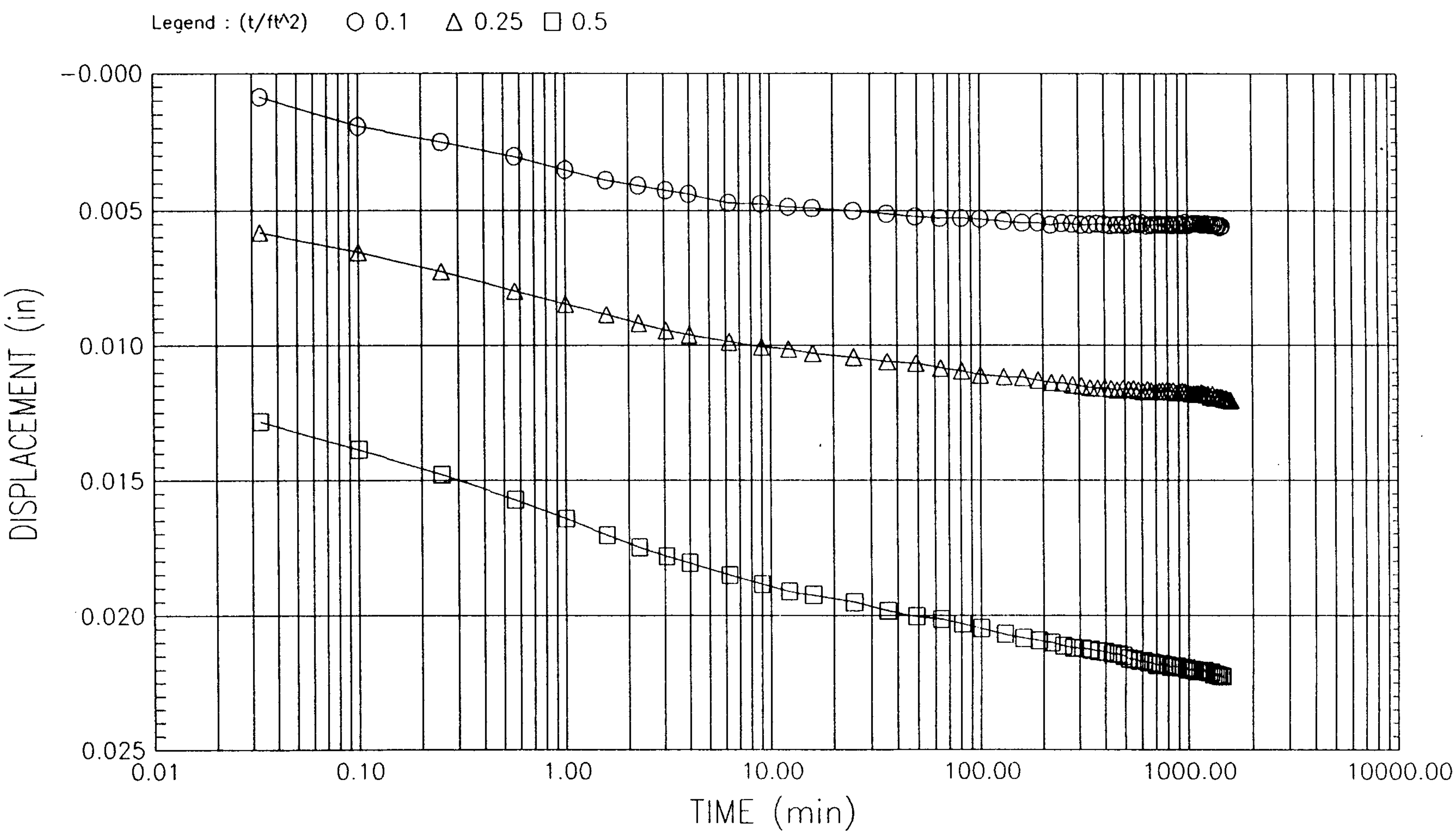


			BEFORE TEST	AFTER TEST
OVERBURDEN PRESSURE (t/ft^2)		WATER CONTENT (%)	34.797	26.578
PRECONSOL. PRESSURE (t/ft^2)		DRY DENSITY (lb/ft^3)	83.103	98.635
COMPRESSION INDEX		SATURATION (%)	88.880	97.283
TYPE SPECIMEN		VOID RATIO	1.088	0.760
DIA. (in) 2.500	HT. (in) 1.000	BACK PRESSURE (t/ft^2)		

CLASSIFICATION Clayey Sand, SC			
LL 46.0	PL 19.0	PI 27.0	PROJECT CHASKA FLOOD CONTROL
GS 2.780	D_{10}		Data File: LPT1

REMARKS Black. Torvane=0.3 TSF.	BORING NO. 92-200 MU1	SAMPLE NO. W-1
Slightly calcareous.	DEPTH 3.0'-5.0'	DATE 2/1/93
	USACE, MRD CONSOLIDATION TEST REPORT	

Figure 6



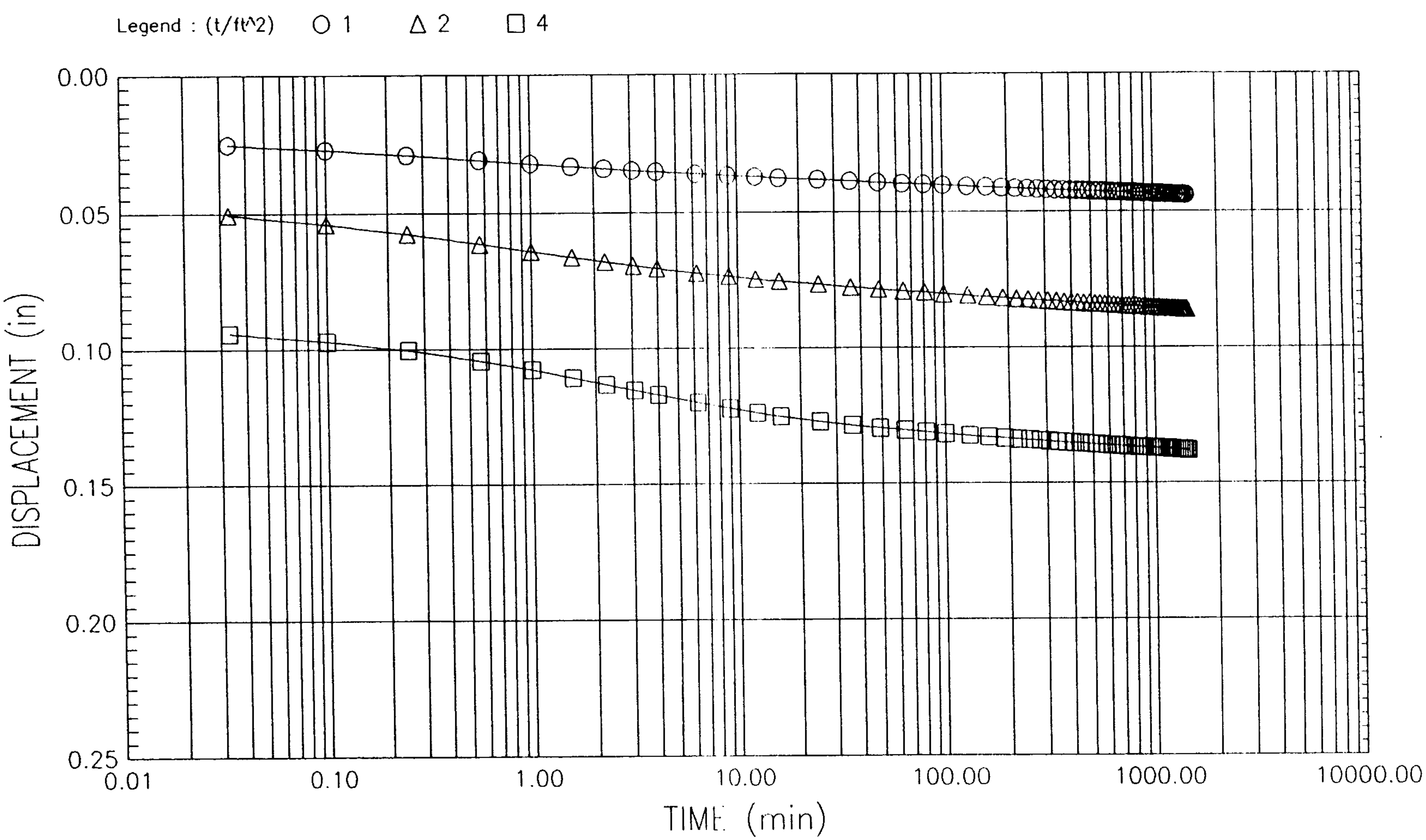
PROJECT	CHASKA FLOOD CONTROL		
	Data File: LPT1		
BORING	92-200 MU1	SAMPLE NO.	W-1
DEPTH	3.0'-5.0'	DATE	2/1/93

USACE, MRD

CONSOLIDATION TEST

TIME CURVES

Figure 7



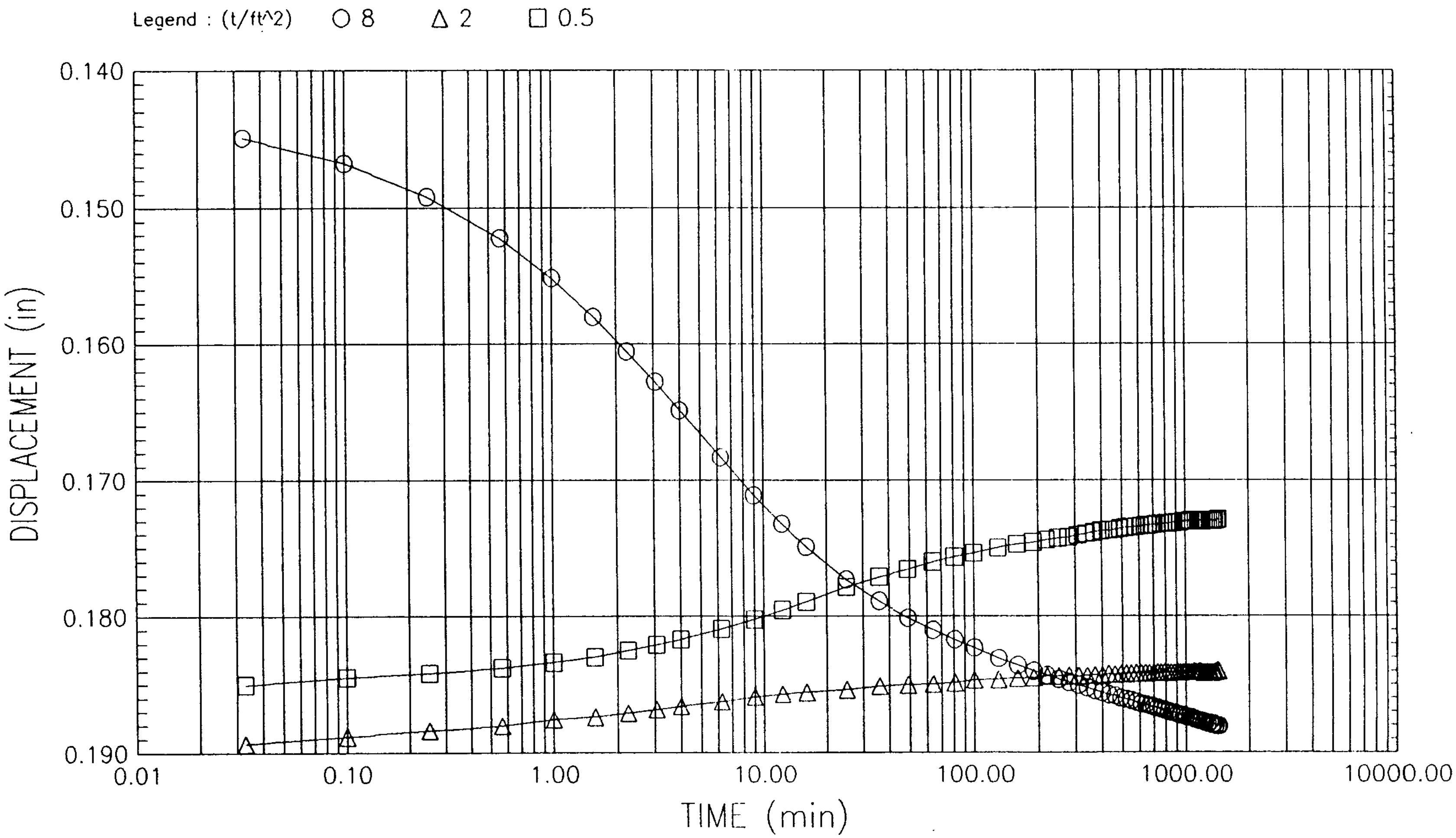
PROJECT	CHASKA FLOOD CONTROL		
	Data File: LPT1		
BORING	92-200 MU1	SAMPLE NO.	W-1
DEPTH	3.0'-5.0'	DATE	2/1/93

USACE, MRD

CONSOLIDATION TEST

TIME CURVES

Figure 8



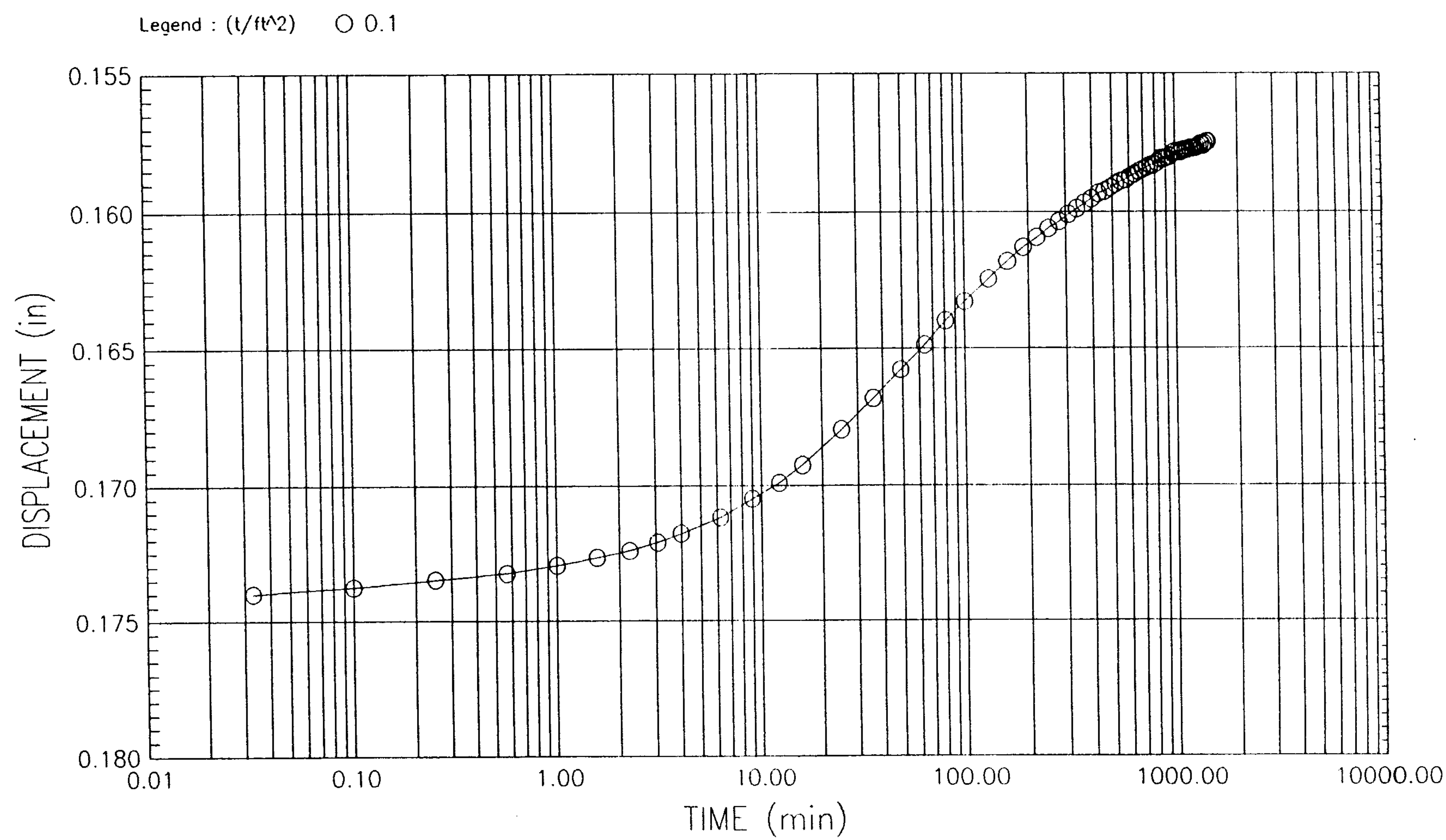
PROJECT	CHASKA FLOOD CONTROL		
	Data File: LPT1		
BORING	92-200 MU1	SAMPLE NO.	W-1
DEPTH	3.0'-5.0'	DATE	2/1/93

USACE, MRD

CONSOLIDATION TEST

TIME CURVÈS

Figure 9



PROJECT	CHASKA FLOOD CONTROL		
	Data File: LPT1		
BORING	92-200 MU1	SAMPLE NO.	W-1
DEPTH	3.0'-5.0'	DATE	2/1/93

USACE, MRD

CONSOLIDATION TEST

TIME CURVES

Figure 10

CONSOLIDATION TEST DATA

Project : CHASKA FLOOD CONTROL Location : EAST CREEK, STAGE 3 Project No. : 1897
Test No. :
Boring No. : 92-200 MU1 Test Date : 2/1/93 Tested by : MJW
Sample No. : W-1 Sample Type : UNDISTURB Depth : 3.0'-5.0'
Checked by :
Soil Description : Black, slightly calcareous, torvane 0.3 TSF.
Remarks :

	APPLIED PRESSURE (t/ft^2)	FINAL DISPLACEMENT (in)	VOID RATIO	STRAIN AT END (%)	FITTING TIME (min) SQ.RT.	FITTING TIME (min) LOG	COEFFICIENT OF CONSOLIDATION (in^2/s) SQ.RT.	COEFFICIENT OF CONSOLIDATION (in^2/s) LOG	COEFFICIENT OF CONSOLIDATION (in^2/s) AVE
1)	0.10	0.006	1.077	0.56	1.2	0.0	6.75E-004	0.00E+000	0.00E+000
2)	0.25	0.012	1.063	1.20	7.7	0.0	1.05E-004	0.00E+000	0.00E+000
3)	0.50	0.022	1.042	2.23	9.5	0.0	8.31E-005	0.00E+000	0.00E+000
4)	1.00	0.044	0.996	4.41	11.6	0.0	6.61E-005	0.00E+000	0.00E+000
5)	2.00	0.086	0.909	8.61	7.8	0.0	9.17E-005	0.00E+000	0.00E+000
6)	4.00	0.138	0.800	13.80	5.7	0.0	1.13E-004	0.00E+000	0.00E+000
7)	8.00	0.188	0.696	18.81	5.6	0.0	1.02E-004	0.00E+000	0.00E+000
8)	2.00	0.184	0.704	18.40	7.5	0.0	7.27E-005	0.00E+000	0.00E+000
9)	0.50	0.173	0.727	17.29	15.5	0.0	3.58E-005	0.00E+000	0.00E+000
10)	0.10	0.158	0.759	15.75	38.2	0.0	1.50E-005	0.00E+000	0.00E+000

TRIAXIAL TEST

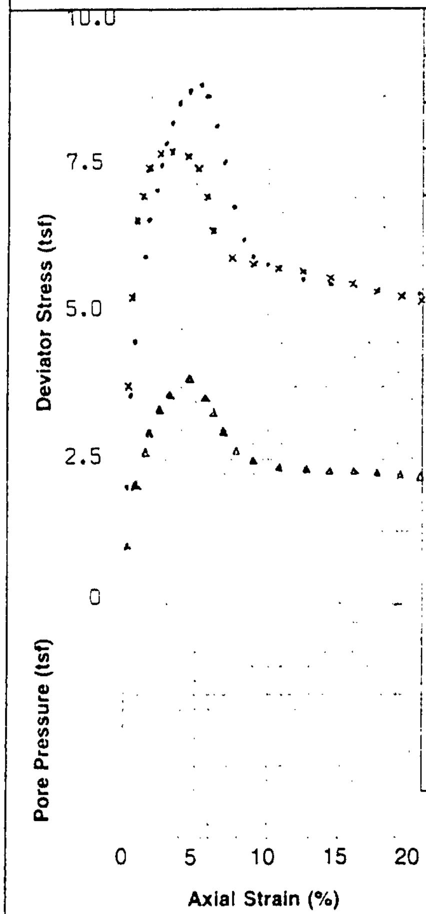
Project Chaska, Stage 3 - P.O. #DACW37-93-M-0610

Location 92-200 Date 4-16-93 Job No. 1906

Boring No. ML2 Sample No. SN-2 Depth (ft.) 20.5-21.7 Type of Sample 5" Core

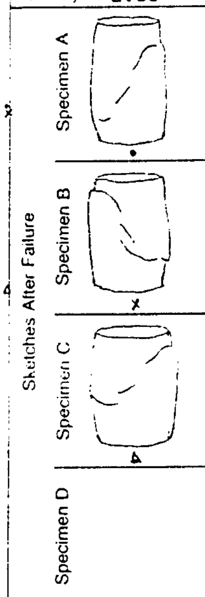
Soil Type Sand w/Silt, fine grained (SP-SM) Type of Test U-U (Saturated)

Remarks Specimens trimmed to given sizes, saturated overnight under low head; drainage valves closed; confining pressure applied and allowed to adjust for about 5 minutes; stressed to given strains at constant rate of 0.06 "/min.

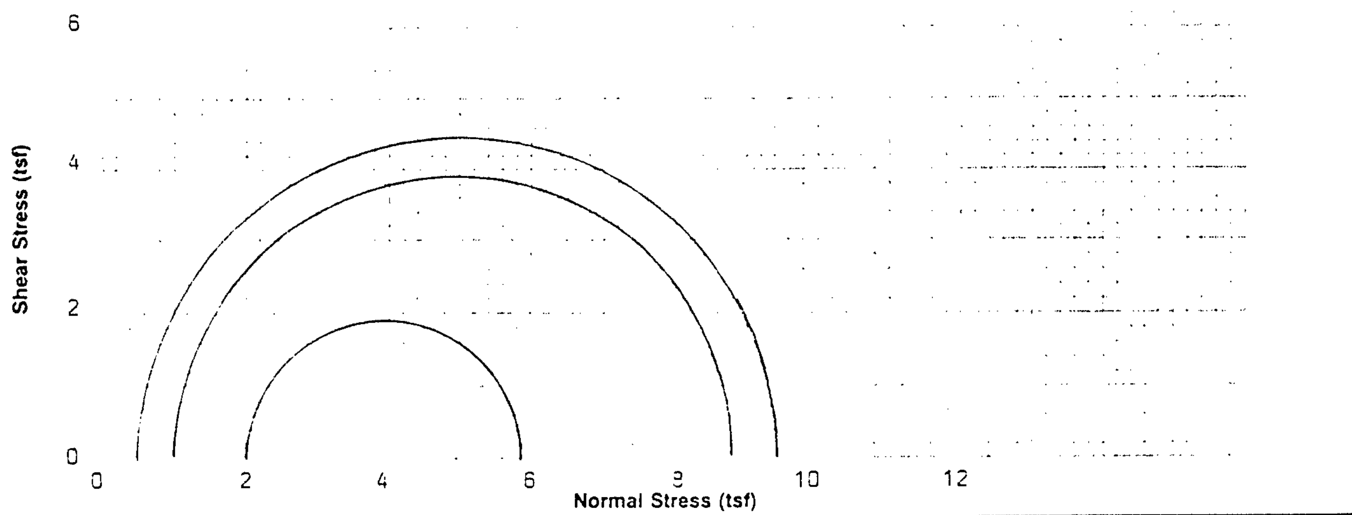


Liquid Limit	
Plastic Limit	
Plasticity Index	
Specific Gravity	2.65

Sketches After Failure



	SPECIMEN NO.	A	B	C	D
Initial	Diameter (inches)	1.41	1.41	1.41	
	Height (inches)	3.14	3.14	3.14	
	Water Content (%)	20.4	21.2	22.1	
	Dry Density (pcf)	96.7	97.2	96.0	
	Void Ratio	0.72	0.71	0.73	
After Consolidation	Diameter (inches)				
	Height (inches)				
	Water Content (%)				
	Dry Density (pcf)				
	Void Ratio				
	Back Pressure (tsf)				
Minor Principal Stress tsf - σ_3		0.50	1.00	2.00	
Max. Deviator Stress tsf ($\sigma_1 - \sigma_3$)		8.99	7.82	3.80	
Ultimate Deviator Stress tsf ($\sigma_1 - \sigma_3$)		5.3	5.2	2.2	
Max. Pore Pressure Buildup - tsf					
Pore Pressure Parameter "B"					



9301 Bryant Avenue South Suite 107 SOIL ENGINEERING TESTING, INC. Bloomington, Minnesota 55420-3436

SET-R14

TRIAXIAL TEST

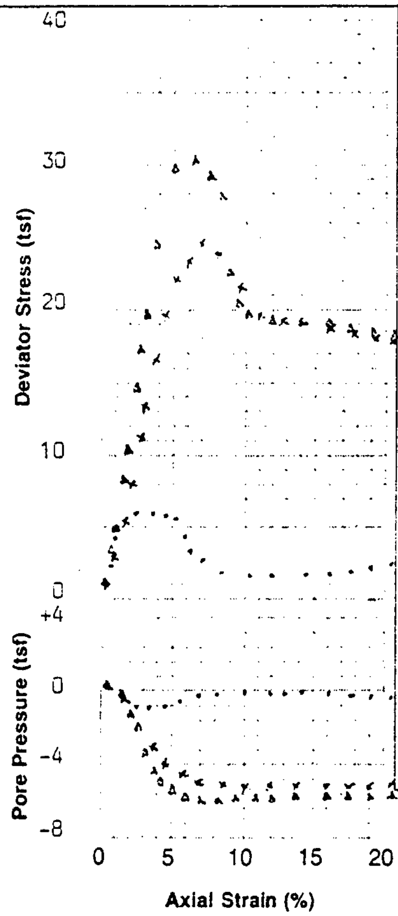
Project: Chaska, Stage 3 - P.O. #DACW37-93M-0610

Location: ______ Date: 4-20-93 Job No.: 1906

Boring No.: 92-200 MU2 Sample No.: SN-2 Depth (ft.): 20.5-21.7 Type of Sample: 5" Core

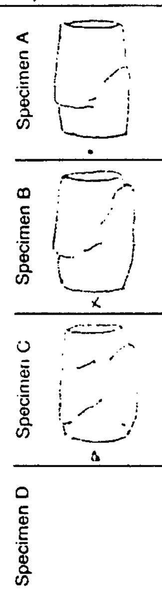
Soil Type: Sand W/Silt, fine grained (SP-SM) Type of Test: C-U w/Pore Pressure

Remarks: Specimens trimmed to given sizes; saturated, backpressured and consolidated for 7-9 days; drainage valves closed and stressed to given strains at constant rate of 0.005 "/min. Mohr Circles at maximum pore pressure buildup.

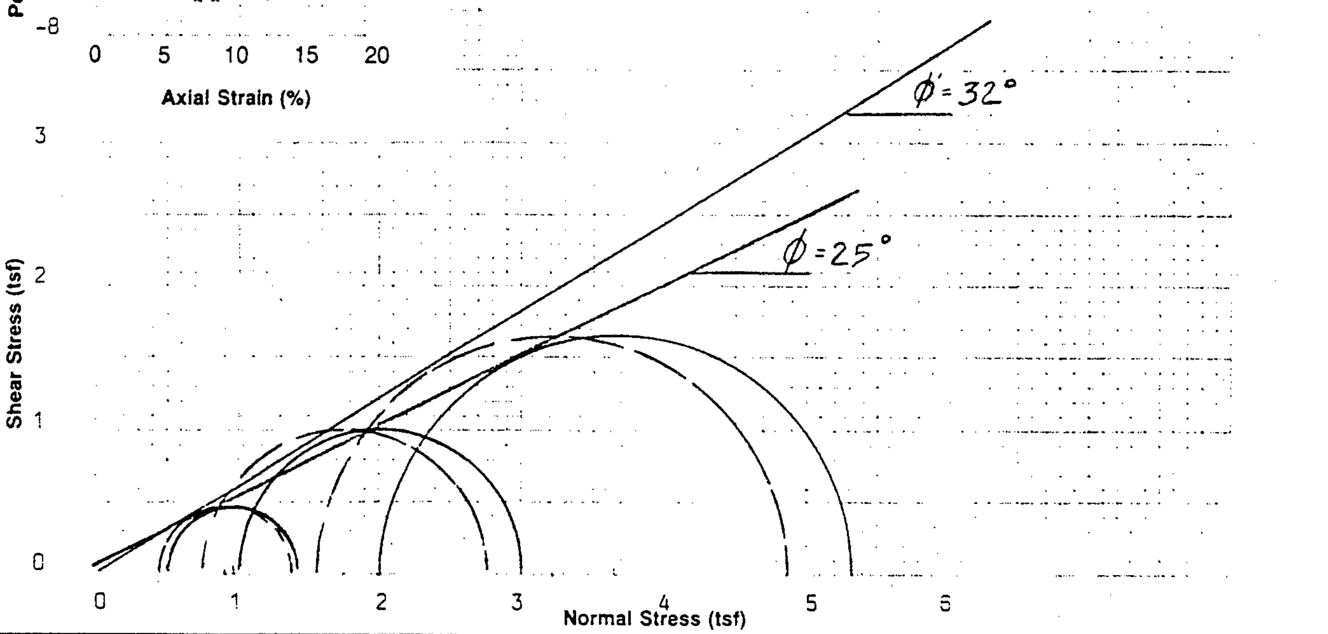


Liquid Limit	
Plastic Limit	
Plasticity Index	NP
Specific Gravity	2.65

Sketches After Failure: Specimen A, Specimen B, Specimen C, Specimen D



	SPECIMEN NO.	A	B	C	D
Initial	Diameter (inches)	1.41	1.41	1.41	
	Height (inches)	3.14	3.12	3.14	
	Water Content (%)	20.9	19.7	19.5	
	Dry Density (pcf)	99.5	101.6	100.4	
	Void Ratio	0.66	0.63	0.65	
After Consolidation	Diameter (inches)	1.39	1.39	1.39	
	Height (inches)	3.12	3.10	3.12	
	Water Content (%)	23.0	21.5	22.5	
	Dry Density (pcf)	102.7	105.4	103.6	
	Void Ratio	0.61	0.57	0.60	
	Back Pressure (tsf)	5.04	5.04	5.04	
Minor Principal Stress tsf - σ_3		0.50	1.00	2.00	
Max. Deviator Stress tsf ($\sigma_1 - \sigma_3$)		6.01	24.57	30.47	
Ultimate Deviator Stress tsf ($\sigma_1 - \sigma_3$)		≃ 1.6	≃ 18	≃ 18	
Max. Pore Pressure Buildup - tsf		0.06	0.25	0.44	
Pore Pressure Parameter "B"		1.0	1.0	1.0	



Laboratory Test Summary

Project: Chaska, Stage 3 - P.O. #DACW37-93-M-0610 Date: 4-20-93

Reported To: St. Paul Dist. U.S. Army Corps of Engineers Job No.: 1906

Boring No.		92-200 MU2				
Sample No.		SN-2				
Depth (Ft)		20.5-21.7				
Type of Sample		5" Core				
Soil Classification (ASTM: D2487/2488)		Sand w/Silt, fine grained (SP-SM)				
Mechanical Analysis Dry Weight (Grams)		463				
Percent Passing						
Gravel	3"					
	2"					
	1"					
	3/4"					
Sand	#4					
	#10	100				
	#40	99.1				
	#100	33.6				
	#200	10.5				
Atterberg Limits						
Liquid Limit						
Plastic Limit						
Plasticity Index						
Moisture - Density						
Water Content (%)						
Dry Density (PCF)						
Unconfined Compression Maximum Load (psf)						
Hand Penetrometer (tsf)						
Organic Content (%)						
pH (Meter Method)						
Specific Gravity		2.65				
Resistivity (ohm-cm)						

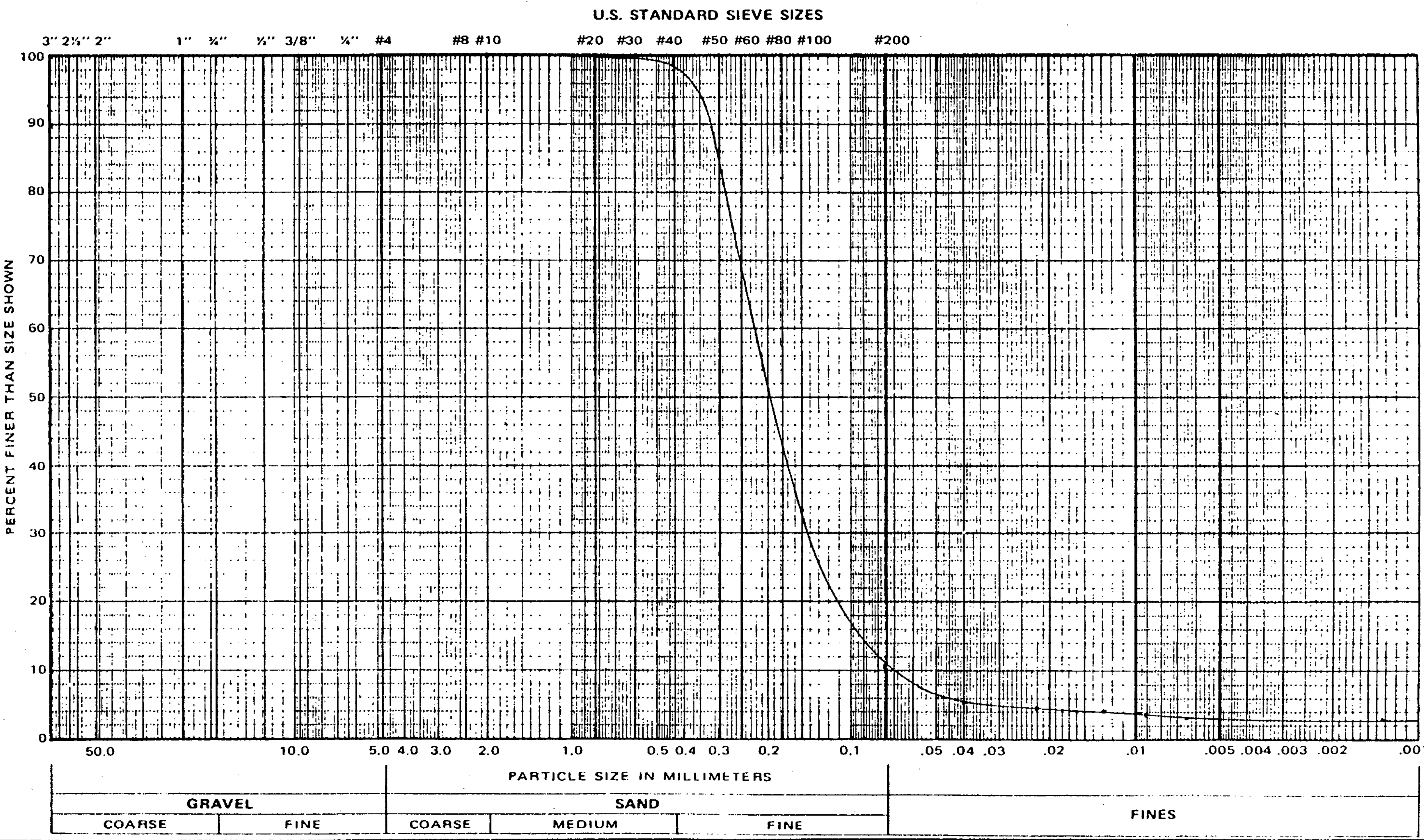
Grain Size Distribution

Boring No.	Sample No.	Depth (ft)	Soil Classification
92-200	SN-2	20.5-21.7	Sand w/Silt, fine grained (SP-SM)
MU2			

Job No: 1906 Date: 4-20-93-0610

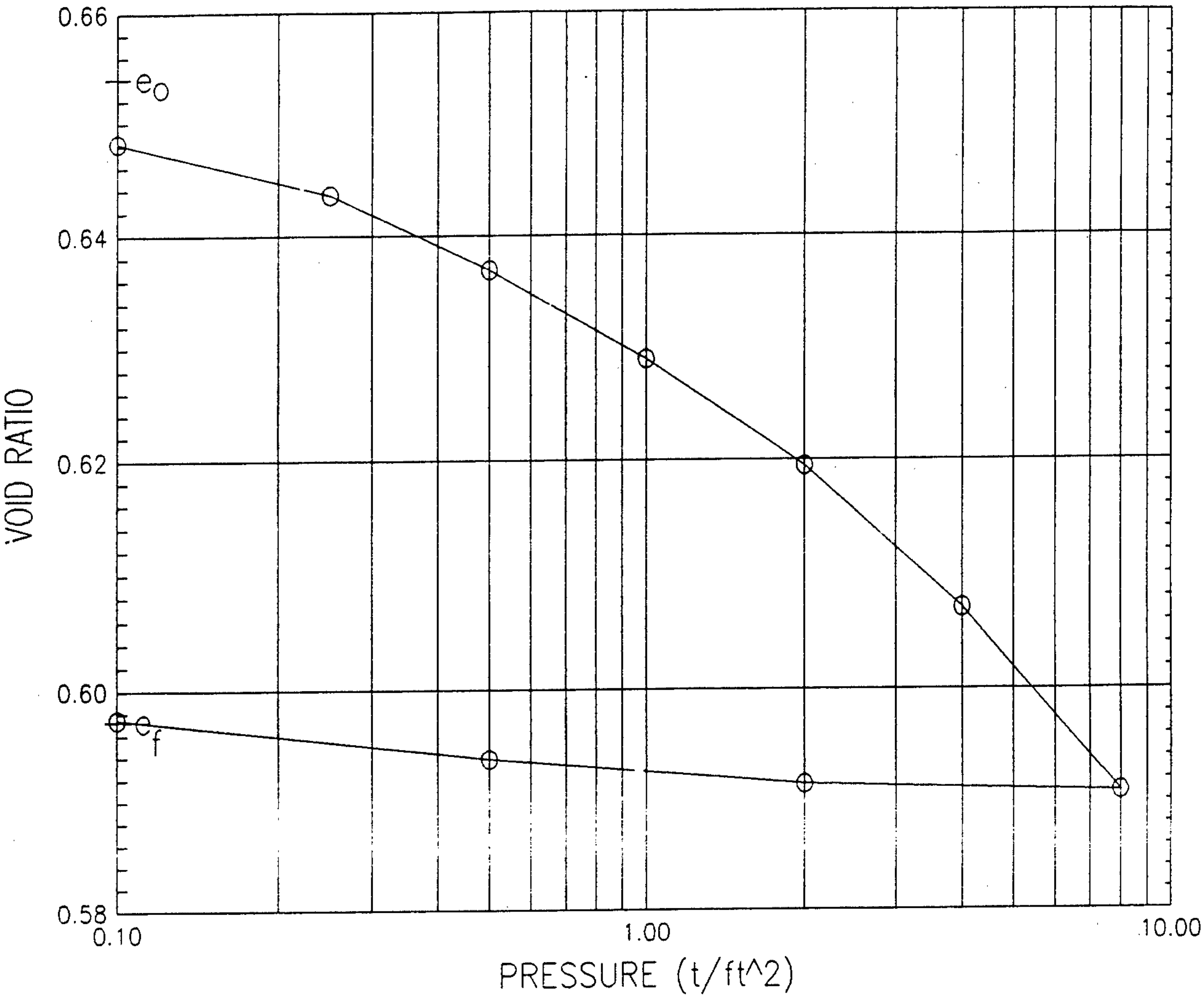
Project: Chaska, Stage 3 - P.O. #DACW37-93M-0610

Reported To: St. Paul Dist. U.S. Army Corps. of Engineers



9301 Bryant Avenue South Suite 107 SOIL ENGINEERING Bloomington, Minnesota 55420 3436

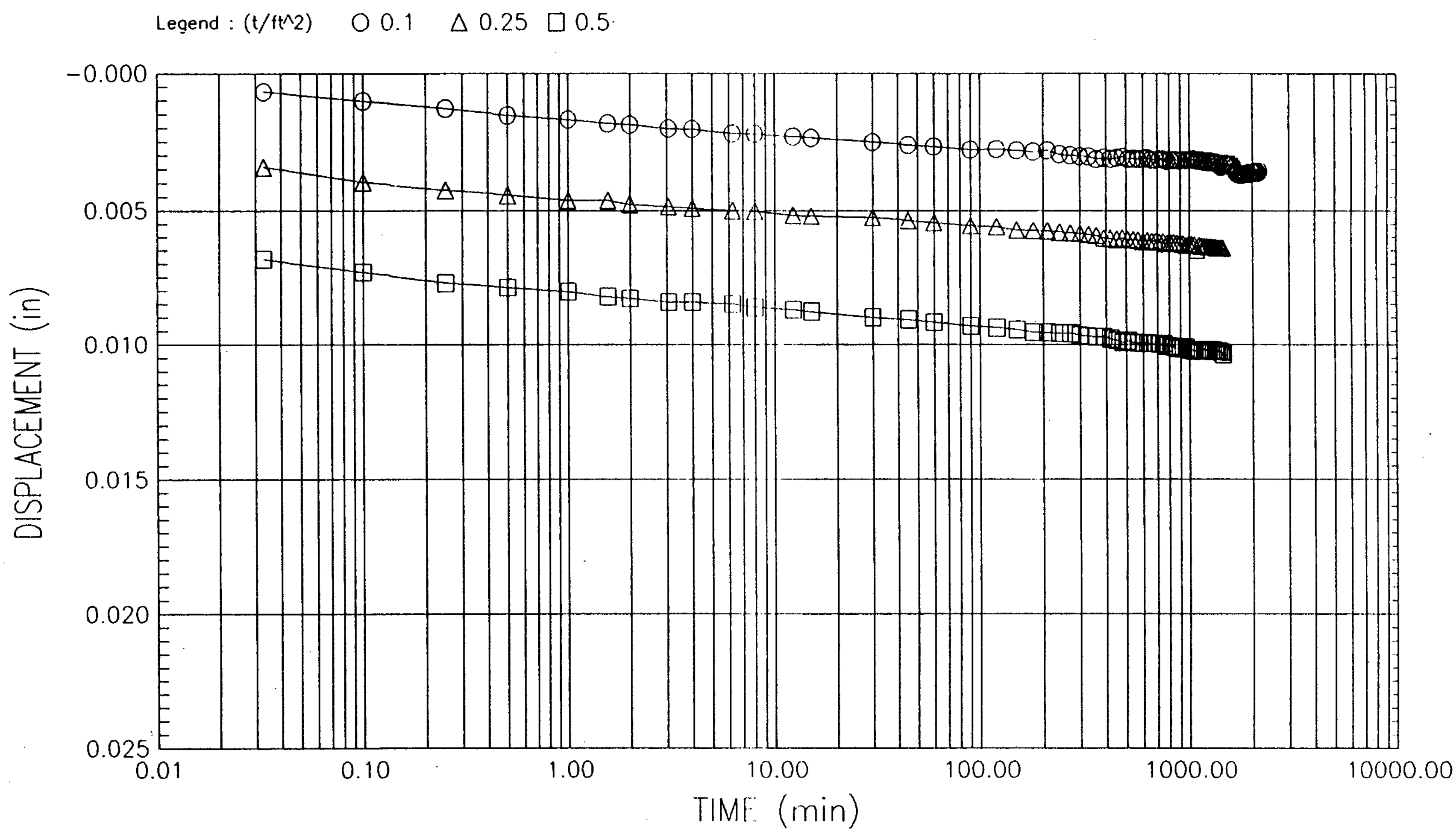
FIGURE D-375



			BEFORE TEST	AFTER TEST
OVERBURDEN PRESSURE (t/ft^2)		WATER CONTENT (%)	23.870	22.830
PRECONSOL. PRESSURE (t/ft^2)		DRY DENSITY (lb/ft^3)	100.765	104.343
COMPRESSION INDEX		SATURATION (%)	97.425	102.029
TYPE SPECIMEN		VOID RATIO	0.654	0.597
DIA. (in) 2.500	HT. (in) 1.000	BACK PRESSURE (t/ft^2)		

CLASSIFICATION Silty Sand, SM		
LL — PL — PI —	PROJECT CHASKA FLOOD CONTROL	
GS 2.670 D_{10}	Data File: LPT1	
REMARKS Non-plastic, yellowish brown,	BORING NO. 92-200 MU1	SAMPLE NO. W-2
Too brittle for torvane. Non-cal-	DEPTH 20.0'-22.0	DATE 2/1/93
careous.	USACE, MRD CONSOLIDATION TEST REPORT	

Figure 16



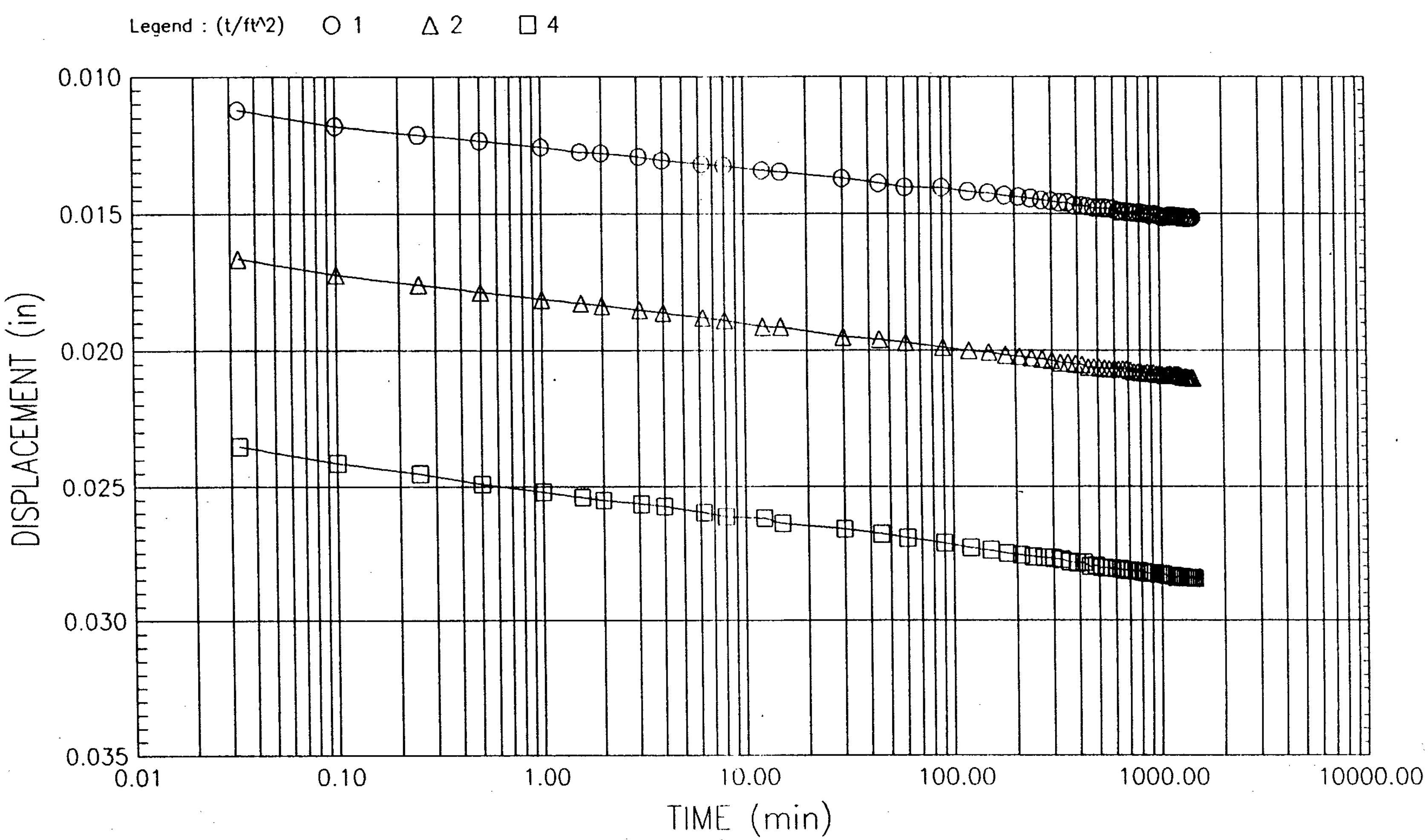
PROJECT	CHASKA FLOOD CONTROL		
	Data File: LPT1		
BORING	92-200 MU1	SAMPLE NO.	W-2
DEPTH	20.0'-22.0	DATE	2/1/93

USACE, MRD

CONSOLIDATION TEST

TIME CURVES

Figure 17



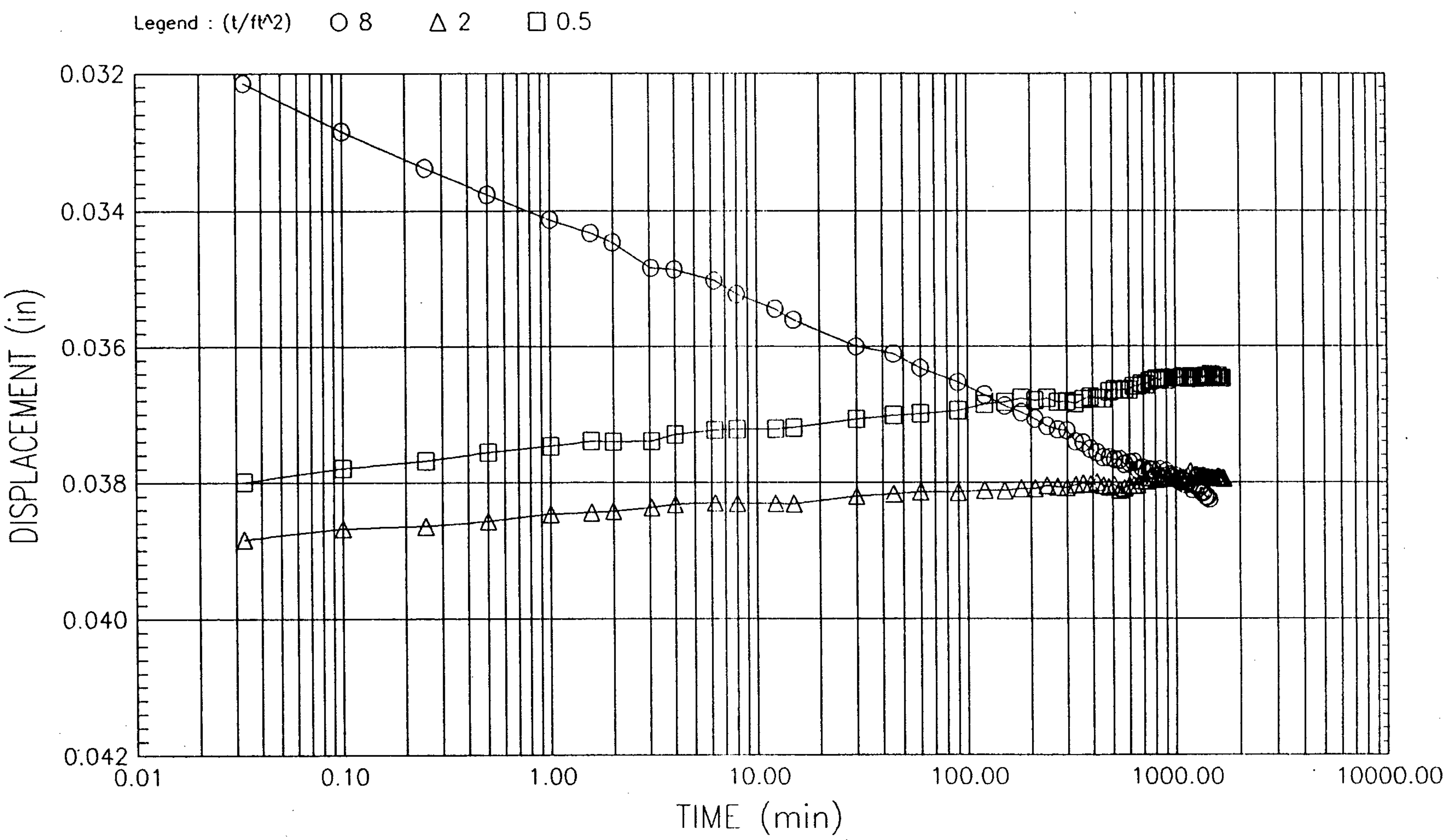
PROJECT	CHASKA FLOOD CONTROL		
	Data File: LPT1		
BORING	92-200 MU1	SAMPLE NO.	W-2
DEPTH	20.0'-22.0	DATE	2/1/93

USACE, MRD

CONSOLIDATION TEST

TIME CURVES

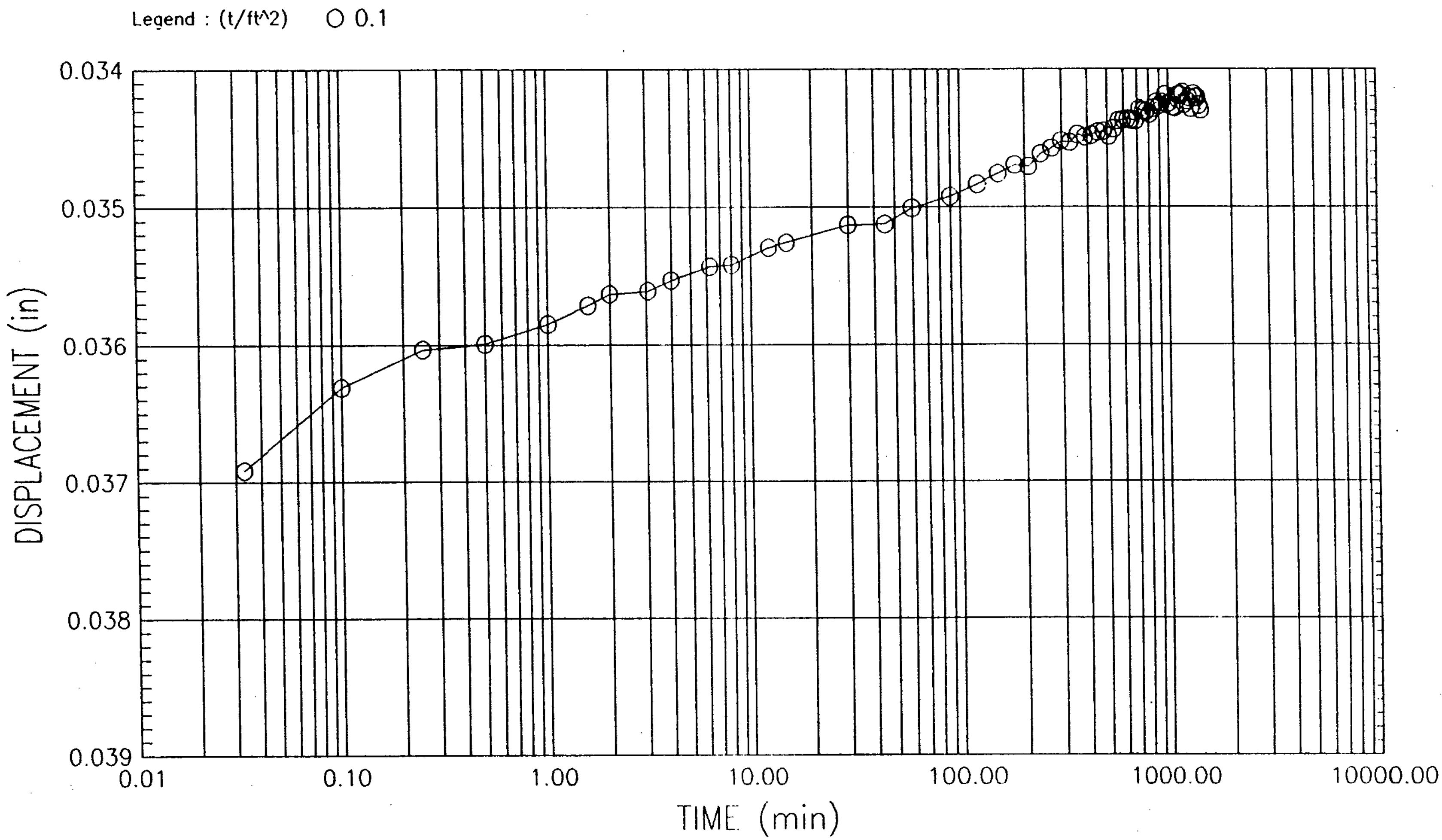
Figure 18



PROJECT	CHASKA FLOOD CONTROL		
	Data File: LPT1		
BORING	92-200 MU1	SAMPLE NO.	W-2
DEPTH	20.0'-22.0	DATE	2/1/93

USACE, MRD
CONSOLIDATION TEST
TIME CURVES

Figure 19



PROJECT	CHASKA FLOOD CONTROL		
	Data File: LPT1		
BORING	92-200 MU1	SAMPLE NO.	W-2
DEPTH	20.0'-22.0	DATE	2/1/93

USACE, MRD

CONSOLIDATION TEST

TIME CURVES

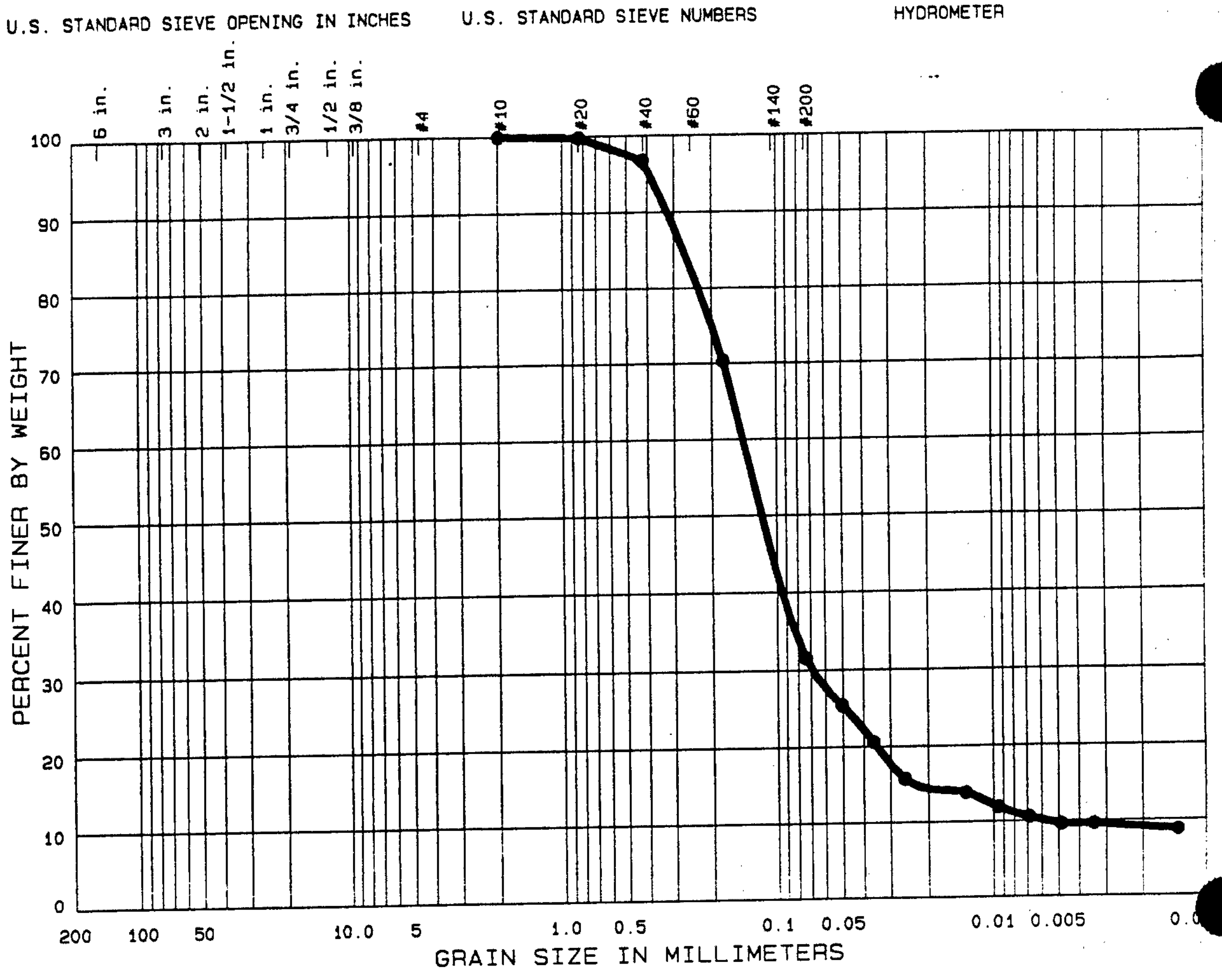
Figure 20

CONSOLIDATION TEST DATA

Project : CHASKA FLOOD CONTROL   Location : EAST CREEK, STAGE 3   Project No. : 1897
Test No. :
Boring No. : 92-200 MU1   Test Date : 2/1/93   Tested by : MJW
Sample No. : W-2   Sample Type : UNDISTURB   Depth : 20.0'-22.0
Checked by :
Soil Description : Yellowish brown, non-calcareous. No torvane.
Remarks :

	APPLIED PRESSURE (t/ft^2)	FINAL DISPLACEMENT (in)	VOID RATIO	STRAIN AT END (%)	FITTING TIME (min)		COEFFICIENT OF CONSOLIDATION (in^2/s)		
					SQ.RT.	LOG	SQ.RT.	LOG	AVE
1)	0.10	0.004	0.648	0.36	18.2	0.0	4.48E-005	0.00E+000	0.00E+000
2)	0.25	0.006	0.644	0.64	17.3	0.0	4.71E-005	0.00E+000	0.00E+000
3)	0.50	0.010	0.637	1.04	47.0	0.0	1.72E-005	0.00E+000	0.00E+000
4)	1.00	0.015	0.629	1.52	27.2	0.0	2.94E-005	0.00E+000	0.00E+000
5)	2.00	0.021	0.619	2.10	22.3	0.0	3.56E-005	0.00E+000	0.00E+000
6)	4.00	0.029	0.607	2.85	24.8	0.0	3.15E-005	0.00E+000	0.00E+000
7)	8.00	0.038	0.591	3.83	26.6	0.0	2.89E-005	0.00E+000	0.00E+000
8)	2.00	0.038	0.591	3.79	2.9	0.0	2.58E-004	0.00E+000	0.00E+000
9)	0.50	0.037	0.594	3.65	6.1	0.0	1.24E-004	0.00E+000	0.00E+000
10)	0.10	0.034	0.597	3.43	24.4	0.0	3.13E-005	0.00E+000	0.00E+000

W.O. No. ch92200w2
Req. No. CENCS-IA-93-30-ED-GH
Contract No.



	% COBBLES	% GRAVEL	% SAND	% SILT OR CLAY	
●	0.0	0.0	68.4	22.0	9.6

	Sample No.	Elev or Depth	Nat W%	LL	PL	PI	C_c	C_u
●	W-2	20.0'-22.0'		NP	NP		6.15	26.4

CLASSIFICATION

● Silty Sand, SM
Specific Gravity = 2.67

Remarks:

Project CHASKA FLOOD CONTROL
EAST CREEK, STAGE 3
Lab No. 1897
Area
Boring No. 92-200 MU1 Date 02/04/93

GRADATION CURVES

CORPS OF ENGINEERS, MISSOURI RIVER DIVISION LAB
420 SOUTH 18th STREET - OMAHA, NE 68102-2586

Figure 21 FIG D38

CLASSIFICATION TEST REQUEST

PROJECT: Chaska Flood Control

ACCOMPANYING TEST: Con, Q, R

CONTAINER - TYPE: 5" W.9X

SAMPLE IDENTIFICATION: 92-200MU 1 W-2 20.0'-22.0'

MRD LAB. NO.:

REQUEST NO.: CENCS-ID-93-30-ED-GH

NO.:

SAMPLE IDENTIFICATION:

Structure: (✓) Brittle ( ) Plastic ( )

Consistency: Undisturbed (X) Soft ( ) Med ( ) Stiff ( ) Hard

Remolded (X) Insensitive ( ) Sl. Sens. ( ) Sensitive

PL Thread: Strength (X) Low ( ) Med ( ) High ( )

Shine (X) None ( ) Dull ( ) Gloss ( ) H. Gloss ( )

Shake Test ( ) None ( ) Slow ( ) Fast (X) Rapid ( )

Torvane: Too brittle

Color: yellowish brown

Disturbance: rocks + sand

Est. Max. Particle Size: 1"

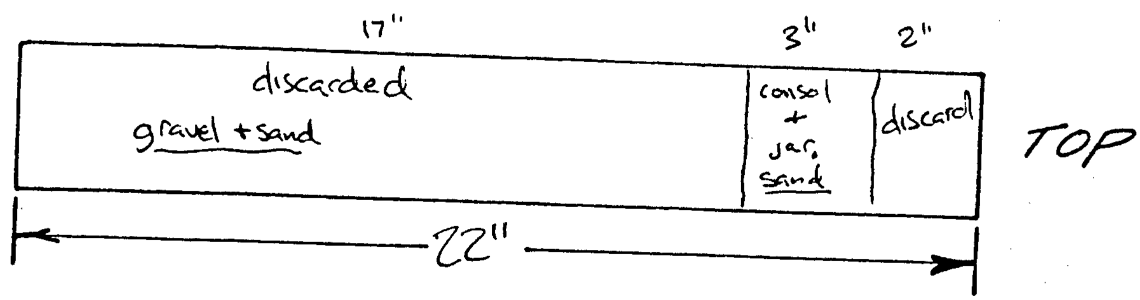
Remarks: sample fell apart while opening. No sample left for Q or R test.

Odor: none

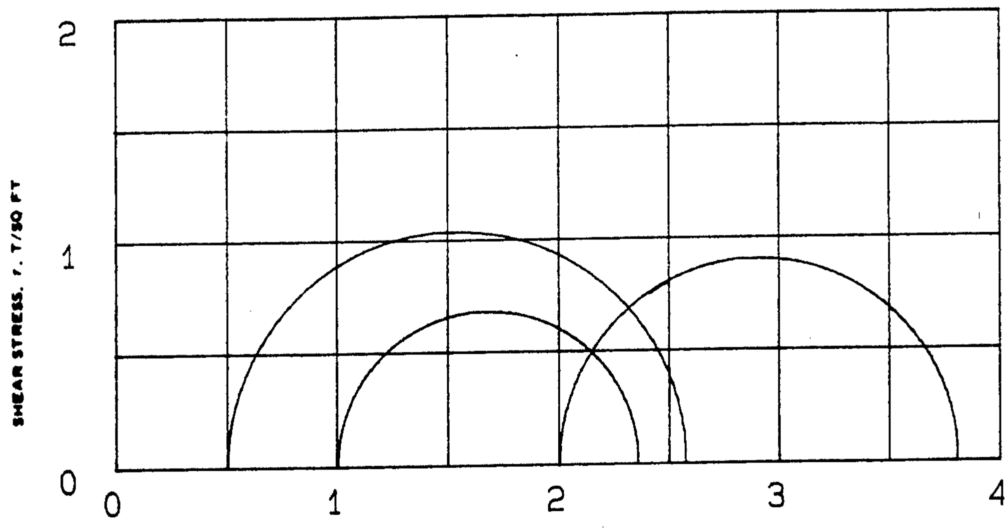
Cementation: no reaction to HCl

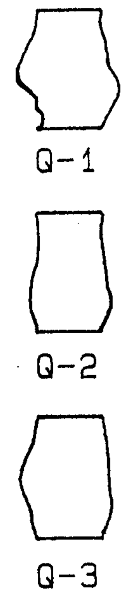
Date Core Opened: 2/1/93

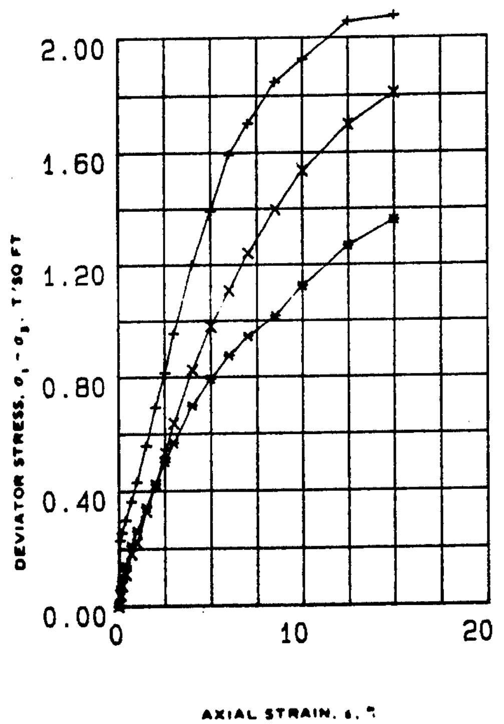
Sketch: (Core description and specimen location)



Technician MJW







SPECIMEN NO.			1 (+)	2 (*)	3 (X)	
INITIAL	WATER CONTENT, %	w_o	23.8	24.5	26.8	
	DRY DENSITY LB/CU FT	γd_o	96.6	97.9	95.4	
	SATURATION, %	S_o	90.0	96.0	98.0	
	VOID RATIO	e_o	0.69	0.67	0.71	
BEFORE SHEAR	WATER CONTENT, %	w_c	25.2	24.6	27.5	
	DRY DENSITY LB/CU FT	γd_c	96.6	97.9	95.5	
	SATURATION, %	S_c	95.0	96.0	100.0	
	VOID RATIO	e_c	0.69	0.67	0.71	
	FINAL BACK PRESSURE, T/SQ FT	u_o	0.0	0.0	0.0	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	0.5	1.0	2.0	
MAXIMUM DEVIATOR STRESS, T/SQ FT	$(\sigma_1 - \sigma_3)_{max}$		2.07	1.36	1.81	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	29.3	35.0	29.8	
ULTIMATE DEVIATOR STRESS, T/SQ FT	$(\sigma_1 - \sigma_3)_{ult}$		2.07	1.36	1.81	
INITIAL DIAMETER, IN.		D_o	1.41	1.41	1.41	
INITIAL HEIGHT, IN		H_o	2.98	2.98	2.97	

CONTROLLED- STRAIN TEST

DESCRIPTION OF SPECIMENS Clayey Sand, SC

LL 24	PL 15	PI 9	G_s 2.62	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST Q

REMARKS: Light yellowish brown.
Torvane=0.15 TSF. Non-calcareous.

PROJECT CHASKA FLOOD CONTROL; CENCS-IA-93-30-ED-

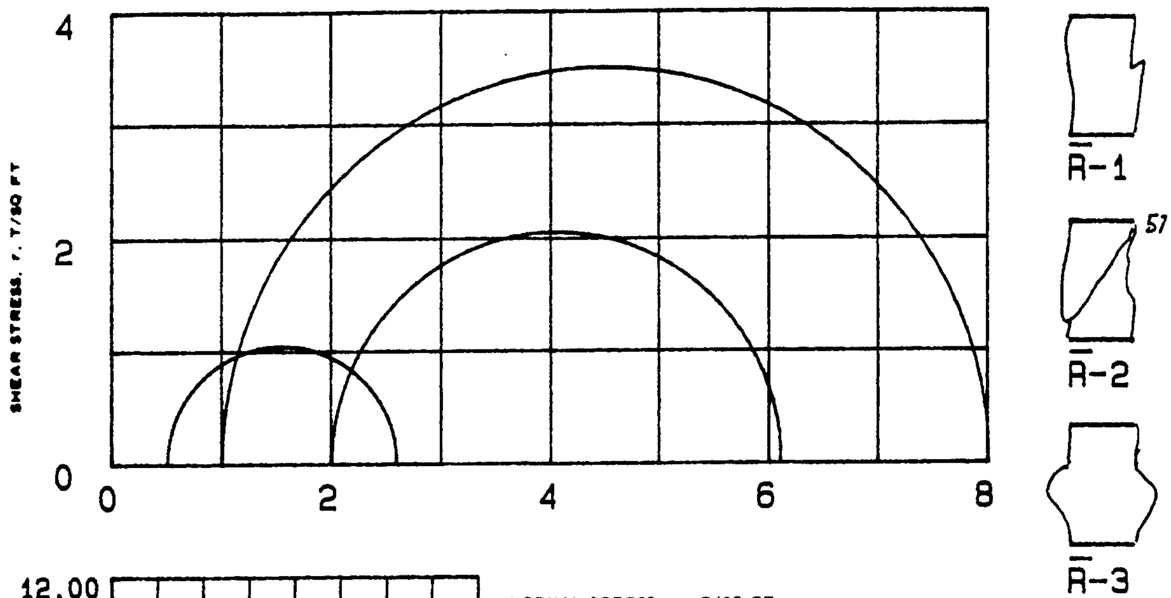
BORING NO 92-200MU2 SAMPLE NO. W-3

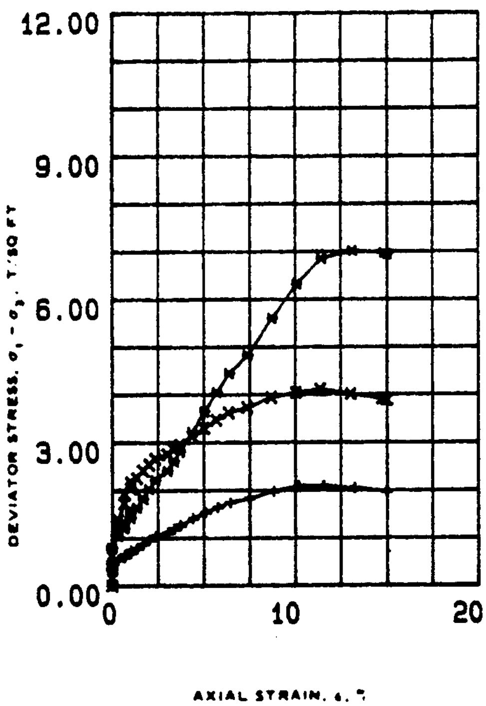
DEPTH ELEV 34.0'-36.0'

LABORATORY 1897 DATE 3-1-93

TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO. 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT *(EM 1110-2-1906)* FIGURE 23





SPECIMEN NO.			1 (+)	2 (*)	3 (X)	
INITIAL	WATER CONTENT, %	w_o	20.9	21.5	24.4	
	DRY DENSITY LB/CU FT	γ_{d_o}	99	101.6	94.2	
	SATURATION, %	S_o	84	92	87	
	VOID RATIO	e_o	.65	.61	.74	
BEFORE SHEAR	WATER CONTENT, %	w_c	26.3	23.9	28.8	
	DRY DENSITY LB/CU FT	γ_{d_c}	98.8	101.5	94.7	
	SATURATION, %	S_c	100	100	100	
	VOID RATIO	e_c	.66	.61	.73	
	FINAL BACK PRESSURE, T/SQ FT	u_o	3.383	3.383	3.383	
MINOR PRINCIPAL STRESS, T/SQ FT		σ_3	.5	1	2	
MAXIMUM DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{max}$	2.088	7.010	4.108	
TIME TO $(\sigma_1 - \sigma_3)_{max}$, MIN		t_f	1200	1440	1320	
ULTIMATE DEVIATOR STRESS, T/SQ FT		$(\sigma_1 - \sigma_3)_{ult}$	1.988	6.937	3.876	
INITIAL DIAMETER, IN.		D_o	1.42	1.38	1.39	
INITIAL HEIGHT, IN.		H_o	2.94	2.97	2.99	
B-Value			1.0	1.0	1.0	

CONTROLLED- STRAIN TEST

Description of Specimens: Clayey Sand, SC

LL 24	PL 15	PI 9	G_s 2.62	TYPE OF SPECIMEN UNDISTURBED	TYPE OF TEST RBAR

REMARKS: Light yellish brown. Torvane 0.15 TSF. Non-calcareous.

PROJECT CHASKA FLOOD; CENCS-IA-93-30-ED-GH

BORING NO 92-200 MU2 | SAMPLE NO. W-3

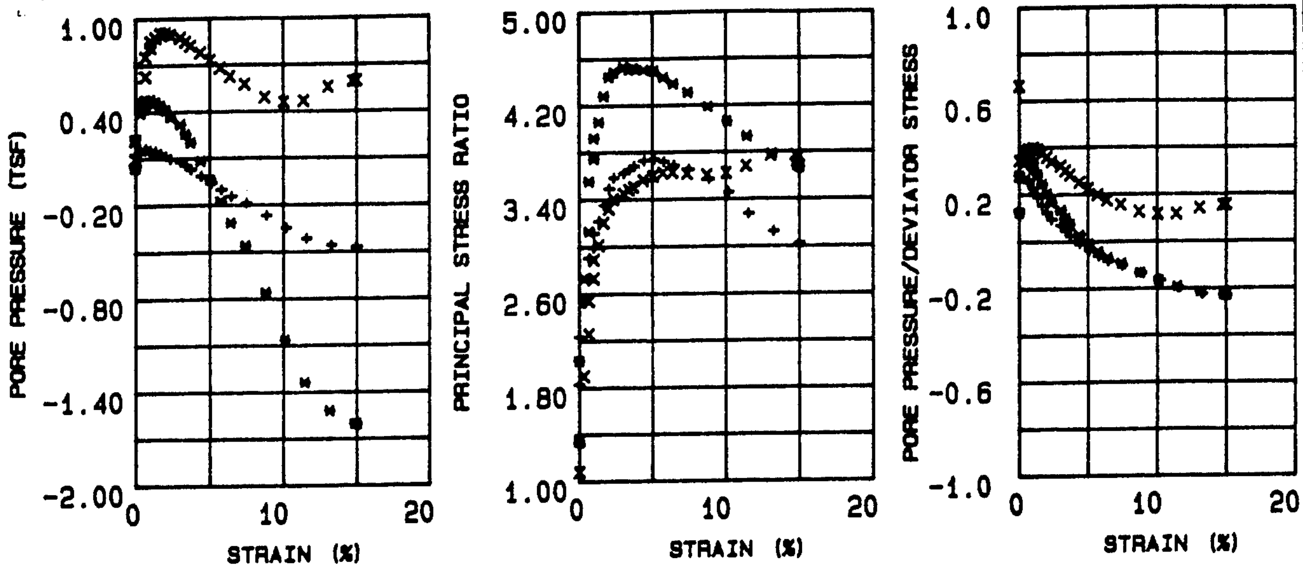
DEPTH ELEV 34'-36'

LABORATORY 1897 | DATE 3-12-93

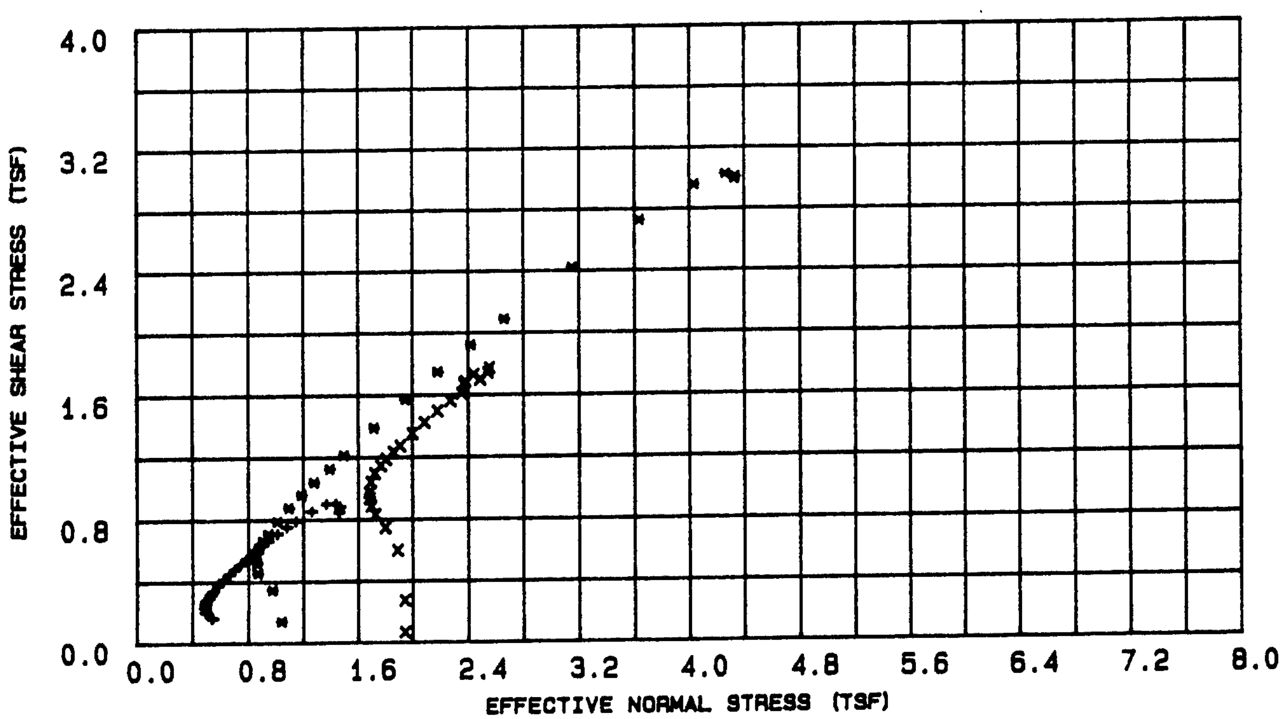
TRIAXIAL COMPRESSION TEST REPORT

ENG FORM NO 2089 REV JUNE 1970 PREVIOUS EDITION IS OBSOLETE TRANSLUCENT (EM 1110-2-1906)

FIGURE 24



EFFECTIVE STRESS VECTOR CURVES ON 60 DEGREE PLANE



LEGEND

+ = .5 TSF
ж = 1 TSF
X = 2 TSF

PROJECT	CHASKA FLOOD; CENCS-IA-93-30-ED-GH
BORING NO.	92-200 MU2
SAMPLE NO.	W-3
DEPTH/ELEV	34'-36'
MRD LAB NO.	1897

FIGURE 25

Table 7 - Triaxial $\overline{R}$ Test Results

Project : CHASKA FLOOD; CENCS-IA-93-30-ED-GH
Boring Number : 92-200 MU2
Sample Number : W-3
Depth : 34'-36'
Confining Pressure : .5 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.00	0.373	0.050	1.827	0.134	0.542	0.161
30	0.00	0.468	0.121	2.235	0.259	0.495	0.202
45	0.34	0.541	0.146	2.529	0.271	0.488	0.233
60	0.68	0.595	0.154	2.720	0.259	0.493	0.257
90	0.68	0.645	0.162	2.907	0.252	0.498	0.278
120	1.02	0.689	0.155	2.996	0.225	0.516	0.297
150	1.02	0.739	0.150	3.113	0.204	0.533	0.319
180	1.36	0.783	0.147	3.216	0.188	0.547	0.338
210	1.70	0.866	0.132	3.353	0.153	0.583	0.374
240	2.04	0.959	0.115	3.491	0.121	0.622	0.414
300	2.38	1.041	0.096	3.581	0.093	0.662	0.449
360	3.06	1.112	0.076	3.620	0.068	0.699	0.480
420	3.40	1.189	0.052	3.652	0.044	0.742	0.513
480	3.74	1.265	0.028	3.680	0.023	0.785	0.546
540	4.42	1.411	-0.017	3.727	-0.012	0.866	0.609
600	5.10	1.537	-0.061	3.740	-0.039	0.942	0.664
720	5.78	1.645	-0.105	3.718	-0.063	1.012	0.710
840	6.46	1.742	-0.149	3.684	-0.085	1.080	0.752
960	7.48	1.832	-0.192	3.649	-0.104	1.145	0.791
1080	8.84	1.979	-0.271	3.566	-0.137	1.261	0.854
1200	10.20	2.088	-0.351	3.455	-0.167	1.368	0.901
1320	11.56	2.088	-0.420	3.271	-0.200	1.437	0.901
1440	13.26	2.040	-0.462	3.120	-0.226	1.467	0.881
1560	14.96	1.961	-0.474	3.014	-0.241	1.459	0.846
1563	15.00	1.968	-0.473	3.022	-0.240	1.460	0.849

Table 8 - Triaxial $\bar{R}$ Test Results

Project : CHASKA FLOOD; CENCS-IA-93-30-ED-GH
Boring Number : 92-200 MU2
Sample Number : W-3
Depth : 34'-36'
Confining Pressure : 1 TSF

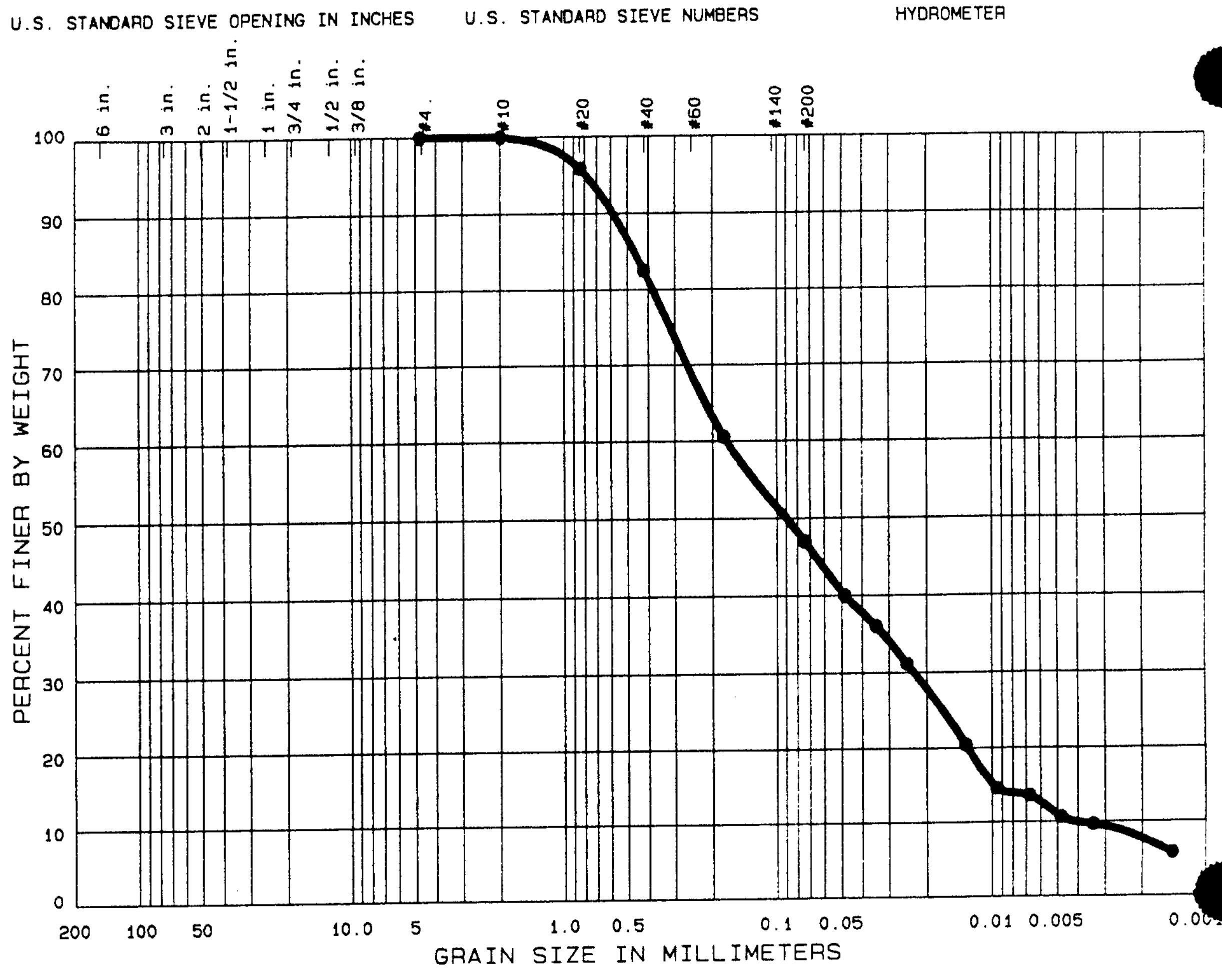
Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.00	0.323	0.040	1.336	0.123	1.040	0.139
30	0.00	0.800	0.225	2.032	0.281	0.973	0.345
45	0.34	1.054	0.392	2.735	0.373	0.869	0.455
60	0.67	1.206	0.434	3.131	0.361	0.864	0.520
90	0.67	1.330	0.479	3.552	0.360	0.850	0.574
120	1.01	1.432	0.478	3.744	0.334	0.877	0.618
150	1.01	1.537	0.474	3.921	0.309	0.907	0.664
180	1.35	1.643	0.463	4.060	0.282	0.944	0.709
210	1.68	1.829	0.443	4.282	0.243	1.010	0.789
240	2.02	2.032	0.410	4.443	0.202	1.093	0.877
300	2.36	2.220	0.364	4.488	0.164	1.186	0.958
360	3.03	2.409	0.318	4.530	0.132	1.278	1.040
420	3.37	2.612	0.255	4.505	0.098	1.392	1.127
480	3.70	2.813	0.200	4.517	0.072	1.496	1.214
540	4.38	3.221	0.081	4.503	0.026	1.716	1.390
600	5.05	3.645	-0.043	4.494	-0.011	1.945	1.573
720	5.73	4.050	-0.179	4.436	-0.044	2.182	1.748
840	6.40	4.452	-0.317	4.381	-0.071	2.419	1.922
960	7.41	4.837	-0.463	4.306	-0.095	2.660	2.088
1080	8.76	5.607	-0.762	4.183	-0.135	3.150	2.420
1200	10.10	6.322	-1.069	4.056	-0.169	3.634	2.729
1320	11.45	6.851	-1.340	3.928	-0.195	4.036	2.957
1440	13.14	7.010	-1.525	3.776	-0.217	4.261	3.026
1560	14.82	6.969	-1.607	3.673	-0.230	4.332	3.008
1576	15.00	6.937	-1.609	3.659	-0.231	4.326	2.994

Table 9 - Triaxial $\bar{R}$ Test Results

Project : CHASKA FLOOD; CENCS-IA-93-30-ED-GH
Boring Number : 92-200 MU2
Sample Number : W-3
Depth : 34'-36'
Confining Pressure : 2 TSF

Time (min)	Strain (%)	Deviator Stress (TSF)	Induced Pore Pressure (TSF)	Principal Eff. Stress Ratio	Pore / Deviator A	Normal Stress (TSF)	Shear Stress (TSF)
15	0.00	0.147	0.097	1.077	0.662	1.939	0.063
30	0.00	0.630	0.216	1.353	0.343	1.940	0.272
45	0.33	1.385	0.456	1.897	0.330	1.887	0.598
60	0.67	1.725	0.628	2.257	0.364	1.799	0.745
90	0.67	1.923	0.752	2.540	0.391	1.724	0.830
120	1.00	2.054	0.814	2.732	0.397	1.694	0.886
150	1.00	2.166	0.854	2.890	0.395	1.682	0.935
180	1.34	2.258	0.878	3.012	0.389	1.681	0.975
210	1.67	2.411	0.905	3.201	0.376	1.692	1.040
240	2.01	2.538	0.906	3.320	0.357	1.722	1.096
300	2.34	2.656	0.894	3.400	0.337	1.764	1.146
360	3.01	2.751	0.876	3.446	0.319	1.805	1.187
420	3.35	2.857	0.850	3.483	0.298	1.857	1.233
480	3.68	2.949	0.823	3.505	0.280	1.907	1.273
540	4.35	3.130	0.778	3.561	0.249	1.997	1.351
600	5.02	3.295	0.730	3.595	0.222	2.086	1.422
720	5.69	3.466	0.678	3.621	0.196	2.180	1.496
840	6.36	3.617	0.623	3.626	0.173	2.272	1.561
960	7.36	3.730	0.572	3.613	0.154	2.352	1.610
1080	8.70	3.935	0.487	3.601	0.124	2.487	1.699
1200	10.04	4.039	0.457	3.618	0.114	2.543	1.743
1320	11.38	4.108	0.465	3.677	0.114	2.552	1.773
1440	13.05	4.005	0.553	3.768	0.139	2.439	1.729
1560	14.73	3.903	0.589	3.766	0.151	2.377	1.685
1584	15.00	3.876	0.593	3.755	0.153	2.367	1.673

W.O. No. CH92200W3
Req. No. CENCS-IA-93-30-ED-GH
Contract No.



% COBBLES		% GRAVEL	% SAND	% SILT OR CLAY	
●	0.0	0.0	53.0	36.1	10.9

	Sample No.	Elev or Depth	Nat W%	LL	PL	PI	C_c	C_u
●	W-3	34.0'-36.0'		24	15	9	0.72	40.7

CLASSIFICATION

● CLAYEY SAND, SC
SPECIFIC GRAVITY = 2.62

Remarks:

Project CHASKA FLOOD CONTROL
EAST CREEK, STAGE 3
Lab No. 1897

Area

Boring No. 92-200MU2 Date 03/04/93

GRADATION CURVES

CORPS OF ENGINEERS, MISSOURI RIVER DIVISION LAB
420 SOUTH 18th STREET - OMAHA, NE 68102-2586

Figure 26 FIGURE D-390

CLASSIFICATION TEST REQUEST

PROJECT: Chaska Flood control

ACCOMPANYING TEST: Q, R

CONTAINER - TYPE: 5" wax

SAMPLE IDENTIFICATION: 92-200M02 U-3 340'-360'

MRD LAB. NO.: 1897

REQUEST NO. CENCS-IA-93-30-ED-GH

NO.:

SAMPLE IDENTIFICATION:

Structure: ( ) Brittle (✓) Plastic ( )

Consistency: Undisturbed (✓) Soft ( ) Med ( ) Stiff ( ) Hard

Remolded (✓) Insensitive ( ) Sl. Sens. ( ) Sensitive

PL Thread: Strength ( ) Low (✓) Med ( ) High ( )

Shine ( ) None (✓) Dull ( ) Gloss ( ) H. Gloss ( )

Shake Test ( ) None (✓) Slow ( ) Fast ( ) Rapid ( )

Torvane: .15 TSF

Color: light yellowish brown

Disturbance:

Est. Max. Particle Size: 1/8"

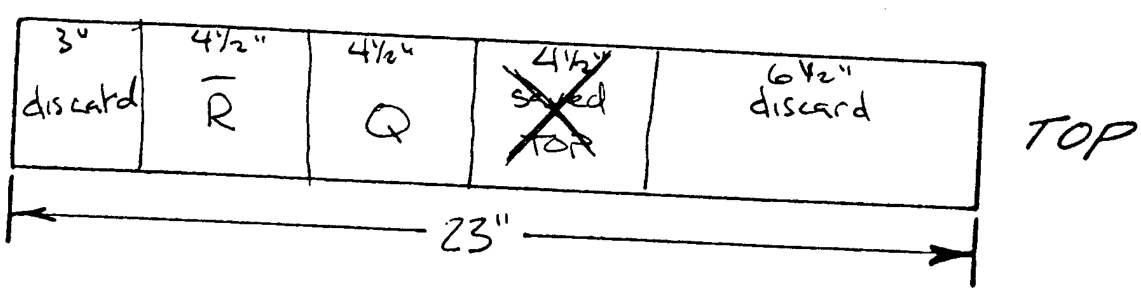
Remarks: layered sand + clay

Odor: None

Cementation:

Date Core Opened: 2/23/93

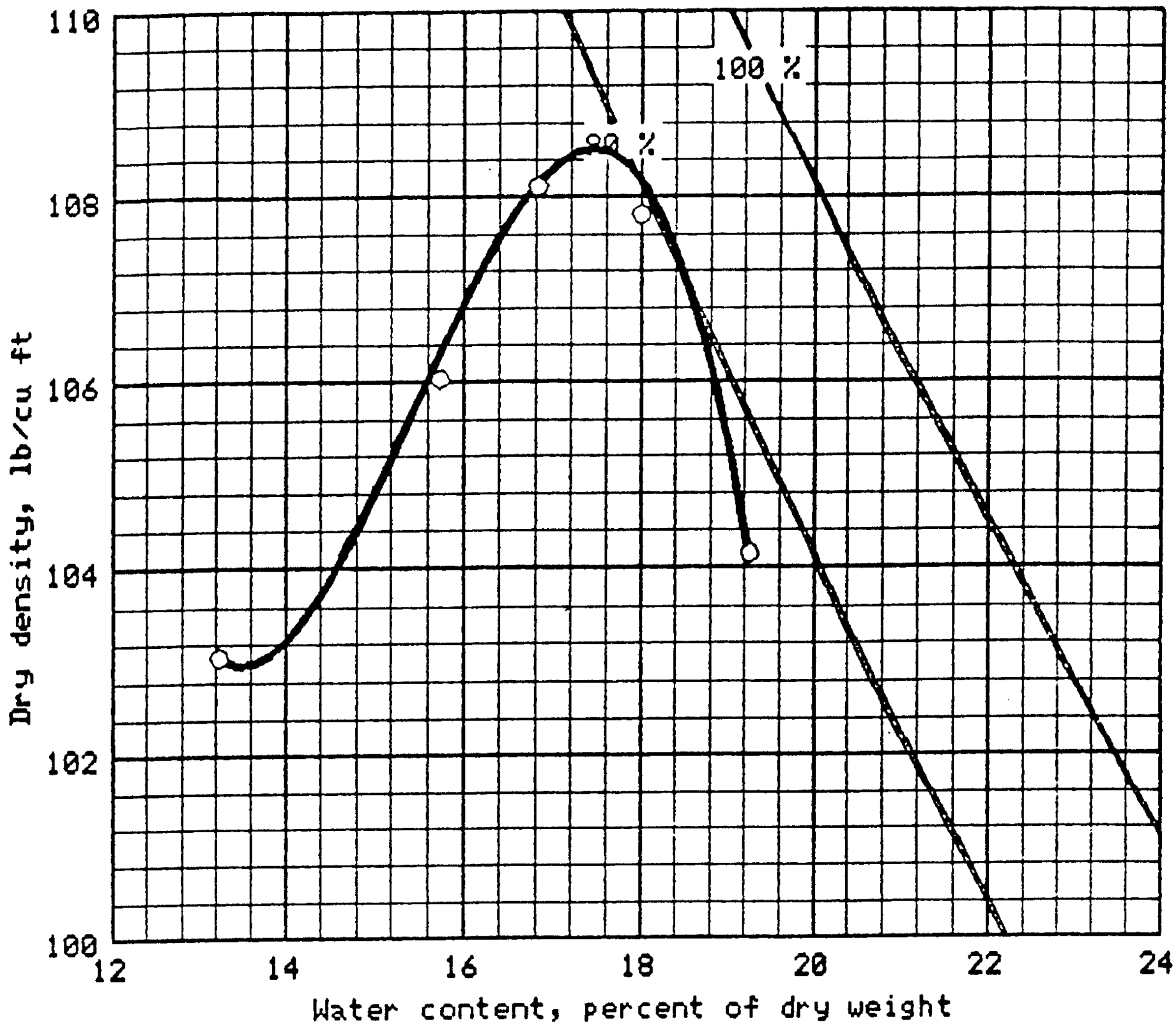
Sketch: (Core description and specimen location)



Technician MJW

Figure 27 FIGURE D-391

WORK ORDER NO. 93-30-ED-GH
Req. No. CENCS-IA-93-30-ED-GH
Contract No. NA



Standard compaction test EM-1110-2-1906
25 blows per each of 3 layers, with 5.50 lb. sl. weight rammer and 12.0 inch drop.   4.0 inch diameter mold

Sample No.	Elev/ Depth	Classification	G	LL	PL	% > No.4	% > 3/4 in.
1 & 2	1.5'-	CLAYEY SAND SC	2.65	35	17	0.9	0
	9.0'						

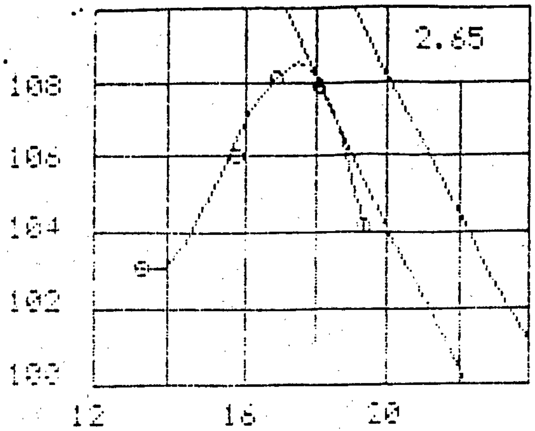
Sample No.	1 & 2			
Water content, percent	2.3	Air dried		
Optimum water content, percent	17.5			
Max dry density, lb/cu ft	108.5			

Remarks:

Project: CHASKA FLOOD CONTROL, EAST CREEK
STAGE # 3
Lab No.: 1897
Area:
Boring No.: 92M-202   Date: 2-19-93

COMPACTION TEST REPORT

CORPS OF ENGINEERS, MISSOURI RIVER DIVISION LAB
420 SOUTH 18th STREET - OMAHA, NE 68102-2586



Project: CHASKA FLOOD CONTROL, EAST CREEK
Lab No.: 1897 Boring No.: 92M-202

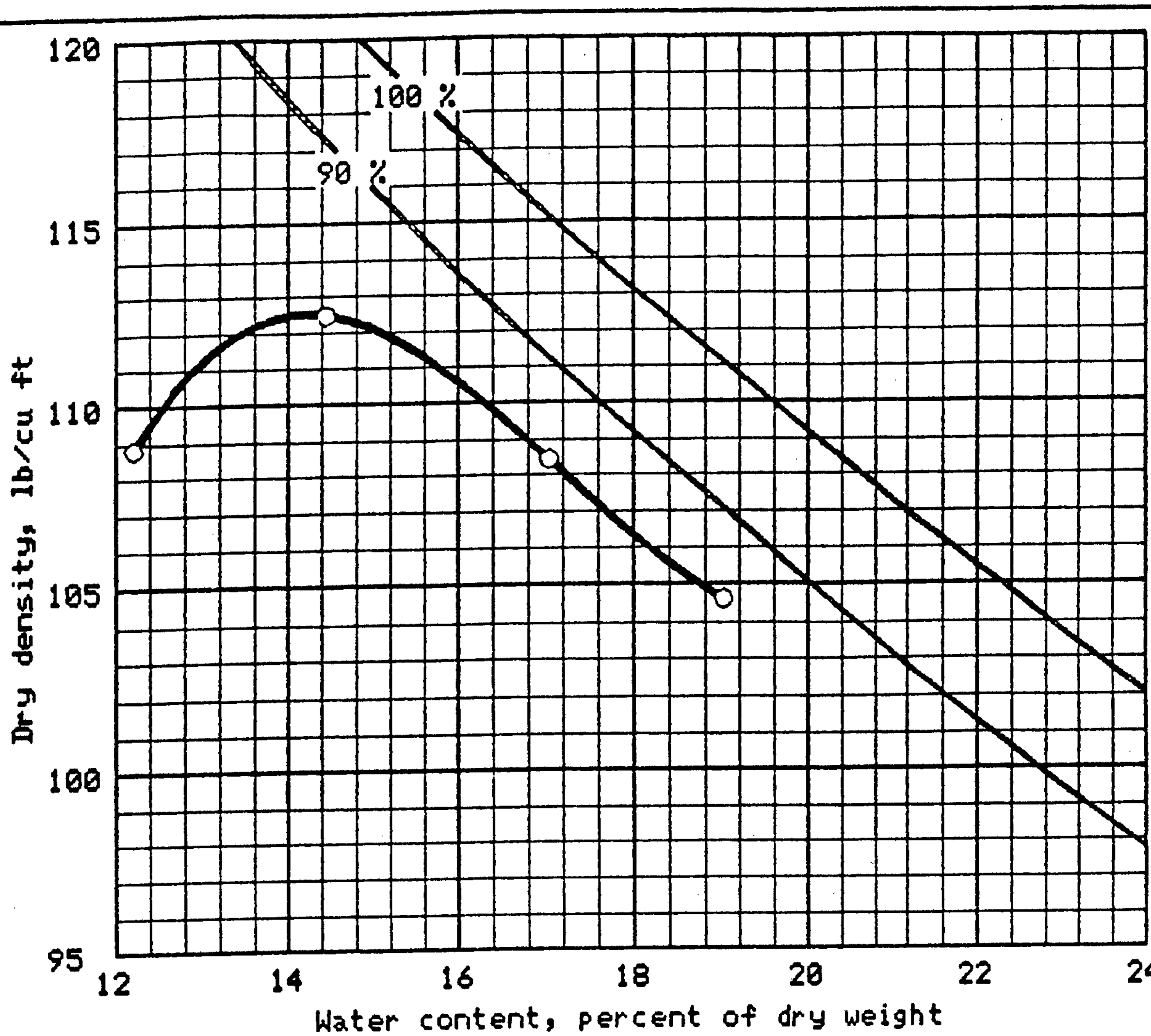
POINT NO.	1	2	3	4	5
WM + WS	8.42	8.22	8.57	8.47	8.54
WM	4.33	4.33	4.33	4.33	4.33
WW+T #1	2012.50	1961.70	2010.40	1811.60	2081.30
WD+T #1	1811.30	1794.30	1784.70	1592.70	1866.40
WT #1	532.90	529.50	530.70	456.00	589.50
MOIST #1	15.7	13.2	18.0	19.3	16.8

MOISTURE	15.7	13.2	18.0	19.3	[illegible]
DRY DEN	10[illegible].2	[illegible]	[illegible]	104.2	108.[illegible]

Max dry den= [illegible] pcf Opt moisture= 17.5 %

FIGURE D-393

WORK ORDER NO. 93-30-ED-GH
Req. No. CENCS-IA-93-30-ED-GH
Contract No. NA



Standard compaction test EM-1110-2-1906
25 blows per each of 3 layers, with 5.50 lb. sl. weight rammer
and 12.0 inch drop. 4.0 inch diameter mold

Sample No.	Elev/ Depth	Classification	G	LL	PL	% > No.4	% > 3/4 in.
BAG	1.5' - 10.0'	SANDY CLAY CL	2.69	35	16	1.0	0.1

Sample No.	BAG			
Water content, percent	2.0	Air-dried		
Optimum water content, percent	14.2			
Max dry density, lb/cu ft	112.5			

Remarks:

Project: CHASKA FLOOD CONTROL, EAST CREEK
STAGE # 3

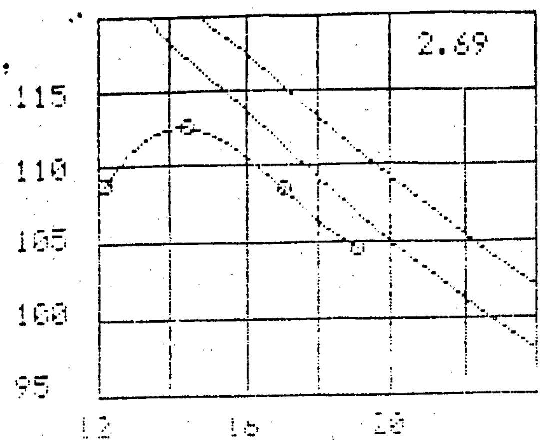
Lab No.: 1897

Area:

Boring No.: 92M-203 | Date: 3-8-932

COMPACTION TEST REPORT

CORPS OF ENGINEERS, MISSOURI RIVER DIVISION LAB
420 SOUTH 18th STREET - OMAHA, NE 68102-2586



Project: CHASKA FLOOD CONTROL, EAST CREEK
Lab No.: 1897   Boring No.: 92M-203

POINT NO.	1	2	3	4
WM + WS	8.62	8.56	8.40	8.48
WM	4.33	4.33	4.33	4.33
WW+T #1	2397.50	2447.10	2300.80	2463.60
WD+T #1	2152.50	2168.00	2079.90	2163.10
WT #1	456.00	529.60	455.00	582.90
MOIST #1	14.4	17.0	12.2	19.0

MOISTURE	14.4	17.0	12.2	19.0
DRY DEN	112.5	10[illegible].4	10[illegible]	104.6

Max dry den= 112.5 pcf Opt moisture= 14.2 %

Figure # 3a   FIGURE D-395

APPENDIX E

STRUCTURAL DESIGN

EAST CREEK AT CHASKA, MINNESOTA
STAGE 3 FEATURE DESIGN MEMORANDUM
FLOOD CONTROL PROJECT

APPENDIX E

STRUCTURAL DESIGN

TABLE OF CONTENTS

UNIT WEIGHTS

4. The assumed unit weights for design were as follows:

Concrete	150 pcf
Water	62.5 pcf
Steel	490 pcf

PERVIOUS BACKFILL

Moist	114 pcf
Saturated	127 pcf

IMPERVIOUS BACKFILL

Moist	115 pcf
Saturated	125 pcf

FROST PROTECTION

5. In general a minimum of 5.5 feet of cover was maintained over retaining wall footings. Riprap was <u>not</u> included as frost protective cover. Frost protection for the drop structure floor slabs, where providing 5.5 feet of frost cover is impractical, will consist of providing free draining material underneath the slab. In-situ material may be used if it is designated as free draining.

STEEL SHEETPILING

6. Steel sheetpiling was assumed to conform to the requirements of ASTM A328 having a yield stress (Fy) of 38,500 psi. The maximum allowable stress conformed to the requirements of EM 1110-1-2101.

SEEPAGE CUTOFF WALLS

7. Cutoff walls were required to control seepage beneath the drop structures and some of the retaining walls. The cutoff walls were designed as reinforced concrete walls and assumed to be 100% effective in order to keep the downstream exit gradient below 0.5 as required by CENCS-ED-GH.

DESIGN FOR SAFETY

8. All of the structures on this project pose a threat to public safety because they are high enough to cause serious injury in case of a fall when in the dry condition and may result in drowning when water is present. In designing for safety, consideration was given to developing features that will help prevent people from falling off the structures and will help prevent drowning. Practical solutions such as handrails and concrete parapets will be implemented.

DESIGN OF STRUCTURES

<u>GATEWELLS</u>

GENERAL

9. Outlet D consists of an 84" RCP, reinforced concrete gatewell, 84" sluice gate, one 84" end section with safety-trash rack and one outlet structure with trash gate and will be constructed at the downstream end of East Creek to prevent Minnesota River flood waters from backing into East Creek and the City of Chaska. Outlet E consists of a 48" RCP, two 48" end sections with safety-trash racks, reinforced concrete gatewell and 48" sluice gate and will be constructed at the upstream end of the project to control the flow in East Creek. Emergency closure

load case - 'Drawdown', no interior water, uplift and exterior water at 3 ft. above end sill elevation, and 250 psf surcharge on backfill. The side walls were then analyzed at the downstream end to determine the reduced reinforcing steel required. The drop wall was analyzed using the Bureau of Reclamation, Monograph No. 27, to determine moments and reactions for rectangular plates, and the end sill was analyzed as a cantilever beam.

16. The retaining wall designs were analyzed using a program written for the Lotus 123 spreadsheet software based on EM 1110-2-2502. Three load cases were analyzed for the downstream retaining walls. The first load case - 'R1', no water on front or backside of wall, no riprap in channel, 50 psf surcharge on backfill, SMF=2/3 and load factor=2.21; the second load case - 'R2', water in front at sill elevation, water in backfill at 3 ft. above sill elevation, riprap in channel, 100 psf surcharge, SMF=3/4 and load factor=2.21; the third load case - 'X', water in front at 4 ft. below sill elevation, water in backfill at design flood elevation, riprap in channel, 100 psf surcharge, SMF=1 and load factor=1.7. Load cases R1 and R2 were analyzed for the upstream retaining walls and no surcharge was used since the backfill actually decreases as you move away from the wall.

17. Joint reinforcement details as well as construction joint location for each drop structures will be determined during the Plans and Specification phase.

DROP STRUCTURE NO. 1

18. Drop structure number 1 is located approximately 825 feet from the end of the diversion channel. The drop structure is a reinforced concrete structure and consists of a 40 foot wide drop wall, a 37 foot long basin, 2 side walls and an end sill. A seepage cutoff wall is required beneath the downstream end of the drop structure. Approximately 67 feet of upstream and 73 feet of downstream retaining walls will be constructed perpendicular to the drop structure. Seepage cutoff walls are required beyond the end of each retaining wall as well as beneath limited portions of the upstream retaining walls.

DROP STRUCTURE NO. 2

19. Drop structure number 2 is located near Stoughton Avenue at station 14+60 of the diversion channel. The drop structure is a reinforced concrete structure and consists of a 30 foot wide drop wall, a 56 foot long basin, 2 side walls and an end sill. A seepage cutoff wall is required beneath the downstream end of the drop structure. The top of the two side walls is setback 2 inches to offset possible deflections in the 37 foot high walls. During design, surcharge was not applied to the sloped backfill behind the side walls. Approximately 95 feet of upstream and 85 feet of downstream retaining walls will be constructed perpendicular to the drop structure. Seepage cutoff walls are required beyond the end of each retaining wall as well as beneath them.

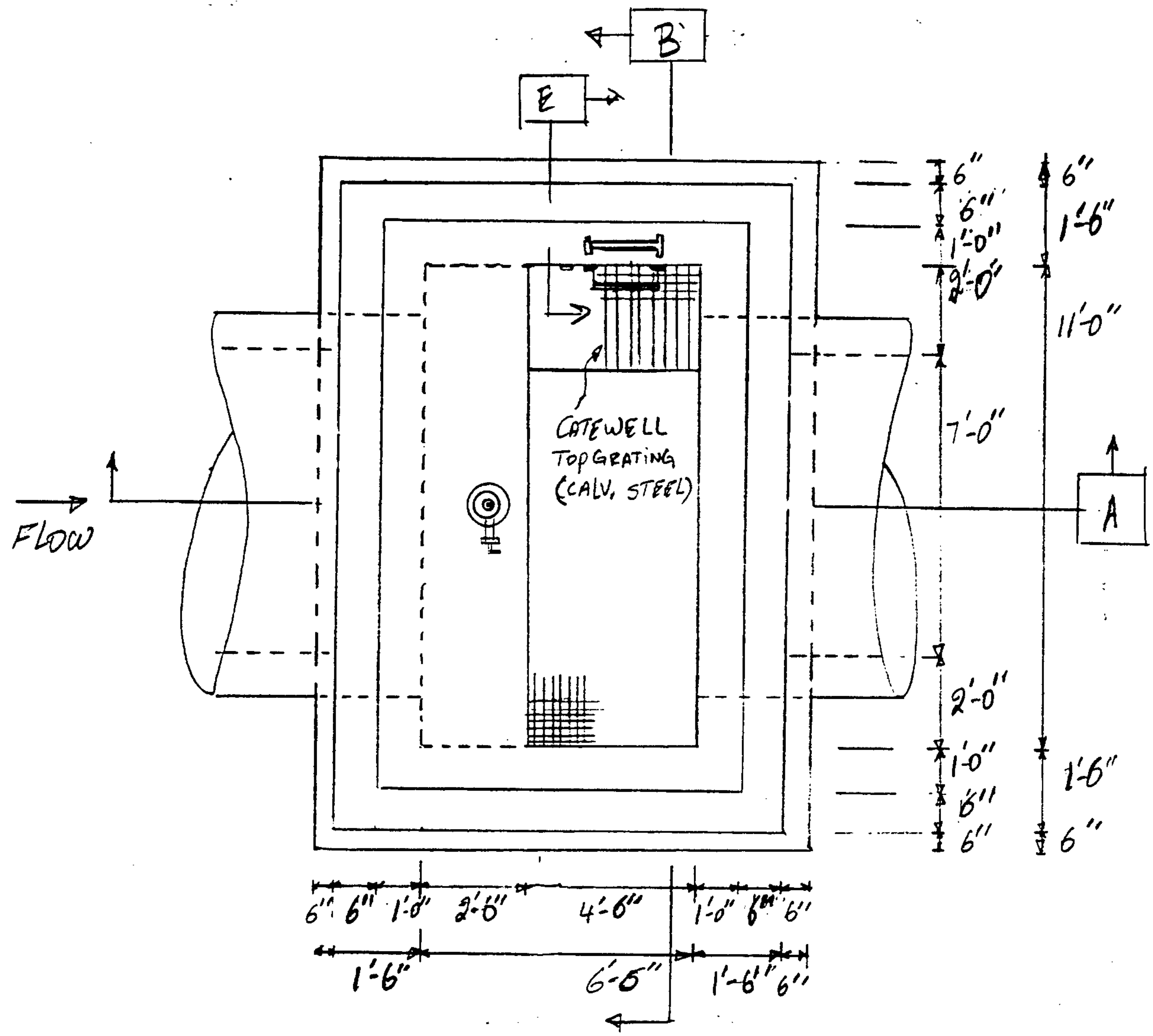
DROP STRUCTURE NO. 3

20. Drop structure number 3 is located at station 32+53 of the diversion channel. The drop structure is a reinforced concrete structure and consists of a 40 foot wide drop wall, a 46 foot long basin, 2 side walls and an end sill. A seepage cutoff wall is required beneath the downstream end of the drop structure. Approximately 77 feet of upstream and 90 feet of downstream retaining walls will be constructed perpendicular to the drop structure. Seepage cutoff walls are required beyond the end of each retaining wall as well as beneath the upstream retaining walls and limited portions of the downstream retaining walls.

SAMPLE COMPUTATIONS

GATEWELL D

US Army Corps of Engineers Saint Paul District	PROJECT TITLE: CHASKA III DM	COMPUTED BY: T. FARES	DATE: 5/8/92	SHEET: 1	28
	SUBJECT TITLE: GATE WELL - D	CHECKED BY: JHM	DATE: 8/11/93	CONTRACT NO.:	

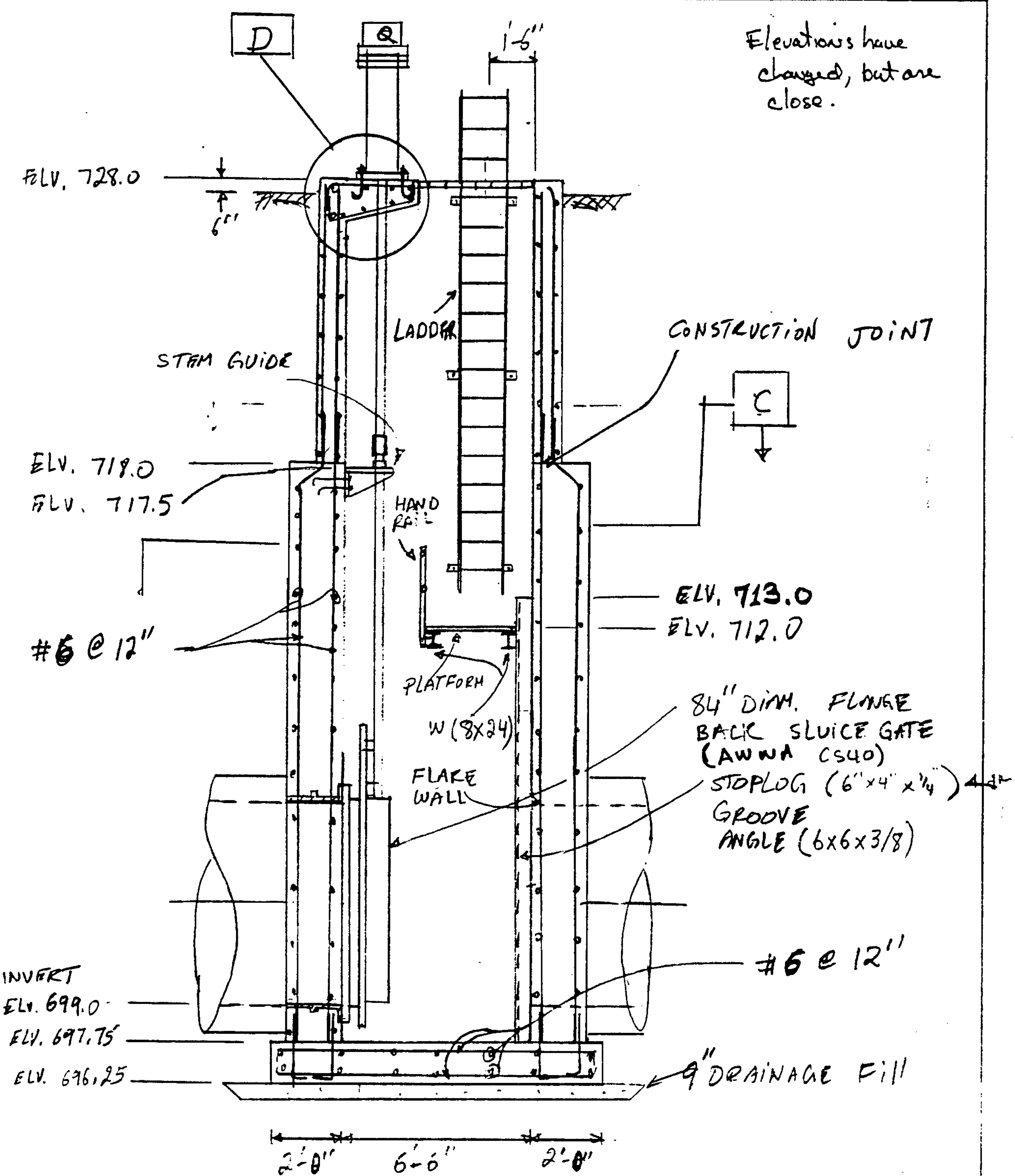


TOP PLAN 1

SCALE: 1/4" = 1'-0"

CENCS 23JAN92

US Army Corps of Engineers Saint Paul District	PROJECT TITLE: CHASKA III DM	COMPUTED BY: TSF	DATE: 5/8/92	SHEET: 3	28
	SUBJECT TITLE: GATE WEll-D	CHECKED BY: JHM	DATE: 8-11-93	CONTRACT NO.:	

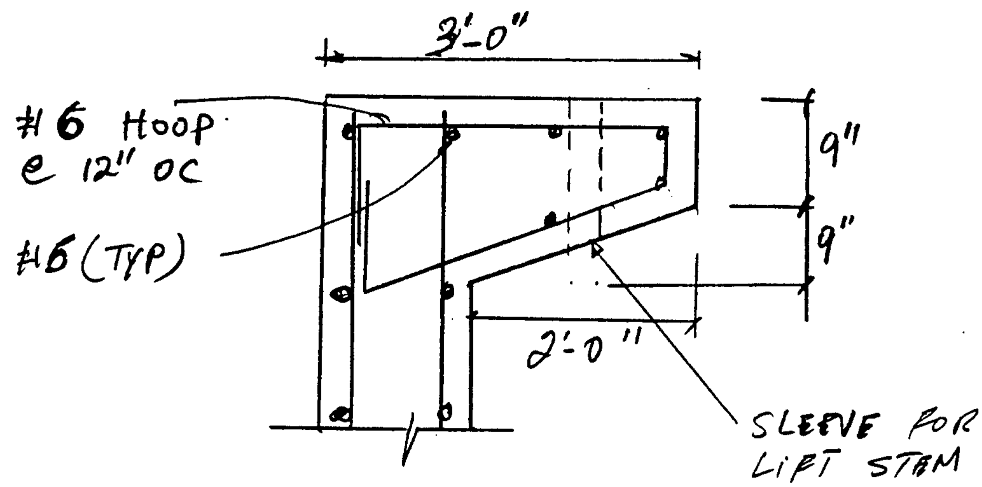


SECTION A

SCALE: 1/5" = 1'-0"

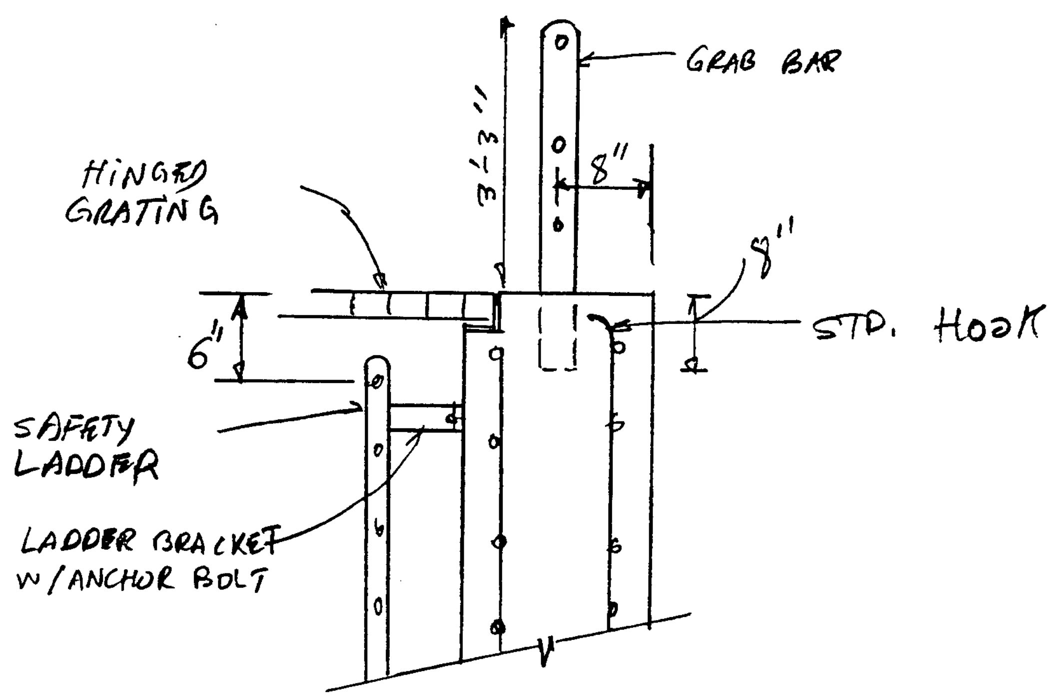
CENCS 23JAN92

US Army Corps of Engineers Saint Paul District	PROJECT TITLE: CHASKA III DM	COMPUTED BY: T. FARES	DATE: 5/21/92	SHEET: 5	28
	SUBJECT TITLE: GATE WELL - D	CHECKED BY: JHM	DATE: 8/11/93	CONTRACT NO.:	



DETAIL D

SCALE



SECTION E

SCALE:

CENCS 23JAN92

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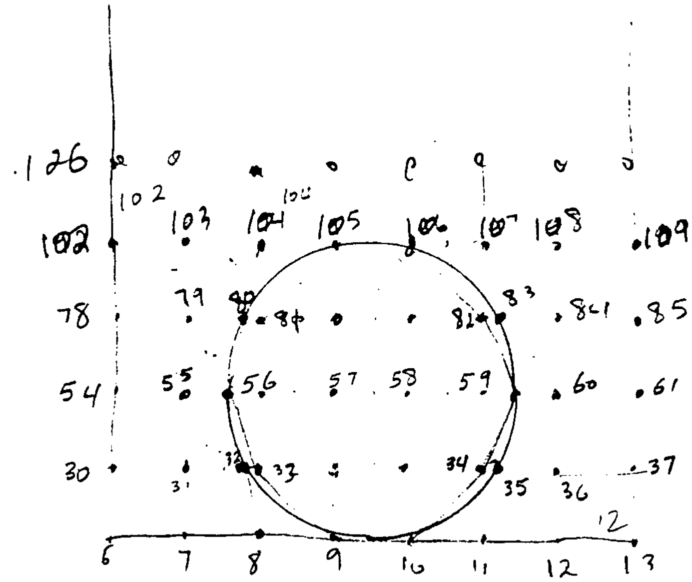

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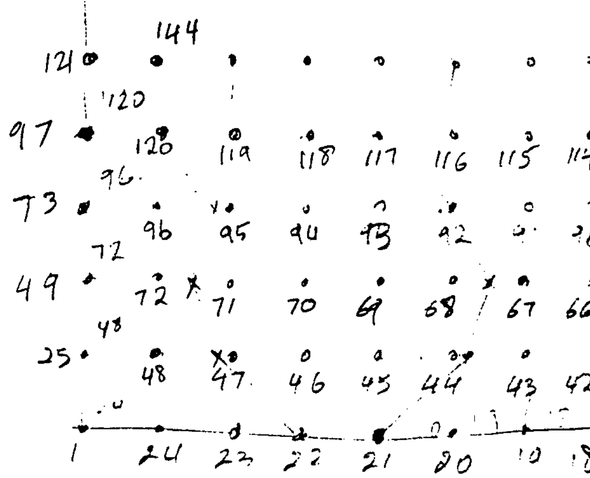

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D, 30, UX, , 54, 24, UY

D, 37, UX, , 61, 24, UY
D, 42, UX, , 66, 24, UY

CENCS 23JAN92

STAGE 4 - GATEWELL "D"

GATEWELL DESIGN VALUES FROM ED-GH 9/28

IMPERVIOUS FILL for stage 4 levee

Q - $c = 0.5$ tsf $\phi = 20°$

R - $c = 0.25$ tsf $\phi = 9°$

S - $\phi = 29.5°$

$\gamma_m \sim 115$ pcf

$\gamma_s - 125$ pcf

Q - Foundation Parameters?

STAGE 3 - GATEWELL "E"

SAME PARAMETERS AS GATEWELL "D"

11/28

Top of well elevation =	728.000
Top of fill elevation =	727.500
Water elevation in the backfill =	725.000
Inside water elevation =	699.000
Ko =	0.515
Y =	0.115
Yw =	0.063
Y saturated =	0.125
Ys =	0.063

Middle Element Elevation	Soil Pressure	Element Pressure	Soil Water Prewssure	Element Pressure	Inside Water Pressure	Element Pressure	Net Element Pressure
	0.000		0.000		0.000		
727.000		0.048		0.000		0.000	0.048
	0.097		0.000		0.000		
725.000		0.122		0.000		0.000	0.122
	0.148		0.000		0.000		
723.000		0.180		0.063		0.000	0.243
	0.212		0.125		0.000		
721.000		0.245		0.188		0.000	0.432
	0.277		0.250		0.000		
719.000		0.309		0.313		0.000	0.622
	0.341		0.375		0.000		
717.000		0.373		0.438		0.000	0.811
	0.406		0.500		0.000		
715.000		0.438		0.563		0.000	1.000
	0.470		0.625		0.000		
713.000		0.502		0.688		0.000	1.190
	0.534		0.750		0.000		
711.000		0.567		0.813		0.000	1.379
	0.599		0.875		0.000		
709.000		0.631		0.938		0.000	1.568
	0.663		1.000		0.000		
707.000		0.695		1.063		0.000	1.758
	0.727		1.125		0.000		
705.000		0.760		1.188		0.000	1.947
	0.792		1.250		0.000		
703.000		0.824		1.313		0.000	2.137
	0.856		1.375		0.000		
701.000		0.888		1.438		0.000	2.326
	0.921		1.500		0.000		
699.000		0.959		1.563		0.000	2.522
	0.998		1.625		0.000		
697.000		1.030		1.688		0.063	2.655
	1.062		1.750		0.125		
695.000		1.094		1.813		0.188	2.719
	1.127		1.875		0.250		

13/28

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D,30,UX, ,54,24,UY
D,37,UX, ,61,24,UY
D,42,UX, ,66,24,UY
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EL	NX	NY	NXY	VX	VY	MX	MY	MXY	TH	ASX	ASY	VXRAT	VYRAT
1,	3.30E+00,	5.02E+00,	9.13E-01,	-5.12E-01,	-3.49E+00,	-2.37E+00,	-4.17E+00,	1.95E+00,	18.0,	0.03,	0.04,	0.03,	0.19
2,	1.47E+00,	8.36E+00,	1.16E+00,	2.24E-01,	-9.45E+00,	-3.01E+00,	-1.37E+01,	2.30E+00,	18.0,	0.00,	0.00,	0.01,	0.51
3,	1.09E+00,	9.90E+00,	-4.73E-02,	-2.69E-01,	-1.21E+01,	-3.06E+00,	-1.60E+01,	1.62E+00,	18.0,	0.00,	0.00,	0.01,	0.66
4,	1.53E+00,	8.46E+00,	-1.20E+00,	-5.76E-01,	-9.20E+00,	-2.09E+00,	-1.32E+01,	7.93E-01,	18.0,	0.00,	0.00,	0.03,	0.50
5,	4.33E+00,	5.38E+00,	-1.00E+00,	1.24E+00,	-4.45E+00,	-1.89E+00,	-3.27E+00,	9.02E-01,	18.0,	0.06,	0.06,	0.07,	0.24
6,	3.13E+00,	6.26E+00,	1.71E+00,	-8.46E-01,	3.50E-01,	-8.51E+00,	-6.35E+00,	4.93E+00,	18.0,	0.00,	0.04,	0.02,	0.02
7,	4.66E-01,	1.06E+01,	6.02E-01,	1.31E-02,	-7.23E+00,	-8.92E+00,	-2.06E+01,	1.20E+01,	18.0,	0.00,	0.00,	0.00,	0.20
8,	4.33E-01,	1.05E+01,	-3.44E+00,	7.64E+00,	-1.27E+01,	-2.33E+01,	-2.49E+01,	2.60E+01,	18.0,	0.00,	0.00,	0.20,	0.34
10,	4.10E+00,	7.42E+00,	3.21E+00,	-7.88E+00,	-1.11E+01,	-1.58E+01,	-1.03E+01,	-1.95E+01,	18.0,	0.00,	0.00,	0.21,	0.30
11,	3.72E-01,	1.15E+01,	-5.25E-01,	-1.37E+00,	-7.76E+00,	-9.44E+00,	-2.04E+01,	-1.22E+01,	18.1,	0.00,	0.00,	0.04,	0.21
12,	4.01E+00,	6.84E+00,	-1.85E+00,	1.22E+00,	-1.76E+00,	-8.06E+00,	-5.35E+00,	-6.53E+00,	18.0,	0.00,	0.06,	0.03,	0.10
13,	3.50E+00,	5.03E+00,	7.65E-01,	-5.51E-01,	-3.53E+00,	-1.47E+00,	-3.47E+00,	-6.89E-01,	18.0,	0.05,	0.05,	0.03,	0.19
14,	1.61E+00,	8.32E+00,	1.15E+00,	1.79E-01,	-9.27E+00,	-2.30E+00,	-1.35E+01,	-8.09E-01,	18.0,	0.00,	0.00,	0.01,	0.50
15,	1.13E+00,	9.96E+00,	3.00E-02,	-2.76E-01,	-1.20E+01,	-3.07E+00,	-1.60E+01,	-1.59E+00,	18.0,	0.00,	0.00,	0.01,	0.33
16,	1.49E+00,	8.47E+00,	-1.12E+00,	-6.03E-01,	-9.35E+00,	-2.06E+00,	-1.26E+01,	-2.31E+00,	18.0,	0.00,	0.00,	0.02,	0.51
17,	4.16E+00,	5.41E+00,	-1.00E+00,	1.17E+00,	-4.51E+00,	-2.75E+00,	-4.07E+00,	-1.26E+00,	17.9,	0.04,	0.05,	0.06,	0.24
18,	3.03E+00,	6.26E+00,	1.50E+00,	-7.58E-01,	-2.60E-01,	-8.49E+00,	-6.89E+00,	4.50E+00,	18.0,	0.00,	0.03,	0.02,	0.01
19,	5.77E-01,	1.08E+01,	3.98E-01,	6.33E-02,	-7.47E+00,	-9.16E+00,	-2.10E+01,	1.21E+01,	18.0,	0.00,	0.00,	0.00,	0.20
20,	5.90E-01,	1.07E+01,	-3.61E+00,	7.61E+00,	-1.27E+01,	-2.39E+01,	-2.53E+01,	2.65E+01,	18.0,	0.00,	0.00,	0.20,	0.34
22,	4.12E+00,	7.31E+00,	3.20E+00,	-7.19E+00,	-1.07E+01,	-1.54E+01,	-1.91E+01,	-1.91E+01,	18.0,	0.00,	0.00,	0.20,	0.29
23,	5.19E-01,	1.12E+01,	-1.99E-01,	-1.27E+00,	-7.72E+00,	-9.23E+00,	-2.06E+01,	-1.10E+01,	18.0,	0.00,	0.00,	0.04,	0.21
24,	3.06E+00,	6.74E+00,	-1.48E+00,	1.22E+00,	-2.44E+00,	-7.83E+00,	-5.87E+00,	-5.54E+00,	17.9,	0.00,	0.06,	0.03,	0.13
25,	6.85E+00,	2.38E+00,	1.03E+00,	-7.98E+00,	9.83E-01,	-4.24E+00,	-6.03E+00,	-1.29E+00,	18.0,	0.00,	0.00,	0.43,	0.03
26,	-3.07E+00,	-2.02E+00,	1.57E+00,	-3.12E+00,	-2.47E+00,	-3.65E+00,	-1.24E+01,	1.48E+00,	18.0,	0.01,	0.00,	0.17,	0.07
27,	-5.83E+00,	-3.36E+00,	-9.09E-02,	-6.01E-02,	-4.05E+00,	-3.22E+00,	-1.47E+01,	9.02E-01,	18.0,	0.07,	0.00,	0.00,	0.11
28,	-2.75E+00,	-1.82E+00,	-1.65E+00,	3.11E+00,	-1.86E+00,	-2.19E+00,	-1.31E+01,	5.33E-01,	18.0,	0.02,	0.00,	0.17,	0.05
29,	8.53E+00,	3.43E+00,	-8.02E-01,	8.80E+00,	2.17E+00,	4.44E-02,	-5.83E+00,	3.92E+00,	18.0,	0.16,	0.00,	0.45,	0.06
30,	8.35E+00,	5.27E+00,	5.26E+00,	-6.78E+00,	3.96E+00,	-9.52E+00,	-9.47E+00,	3.75E+00,	18.0,	0.04,	0.00,	0.36,	0.11
31,	-3.38E-01,	4.53E+00,	6.16E+00,	-6.30E-01,	-8.51E+00,	-1.24E+01,	-3.43E+01,	1.06E+01,	18.0,	0.00,	0.00,	0.02,	0.22
35,	-8.60E-01,	5.00E+00,	-6.45E+00,	6.92E-01,	-1.00E+01,	-1.26E+01,	-3.72E+01,	-1.17E+01,	18.0,	0.00,	0.00,	0.02,	0.25
36,	8.95E+00,	5.93E+00,	-5.27E+00,	7.49E+00,	3.84E+00,	-1.05E+01,	-1.10E+01,	-4.25E+00,	18.0,	0.04,	0.00,	0.40,	0.11
37,	7.70E+00,	2.63E+00,	7.90E-01,	-8.19E+00,	1.03E+00,	1.85E-01,	-4.07E+00,	-3.92E+00,	18.0,	0.15,	0.00,	0.42,	0.06
38,	-2.65E+00,	-1.90E+00,	1.55E+00,	-3.31E+00,	-2.20E+00,	-1.59E+00,	-1.22E+01,	-6.48E-01,	18.0,	0.03,	0.00,	0.18,	0.06
39,	-5.72E+00,	-3.36E+00,	1.26E-03,	-2.14E-01,	-4.02E+00,	-3.23E+00,	-1.47E+01,	-1.02E+00,	18.0,	0.07,	0.00,	0.01,	0.11
40,	-2.96E+00,	-1.97E+00,	-1.50E+00,	2.92E+00,	-1.97E+00,	-4.22E+00,	-1.33E+01,	-1.49E+00,	18.0,	0.00,	0.00,	0.16,	0.05
41,	7.07E+00,	3.05E+00,	-9.38E-01,	8.42E+00,	2.00E+00,	-4.44E+00,	-8.21E+00,	1.47E+00,	18.0,	0.09,	0.00,	0.45,	0.06
42,	7.88E+00,	4.55E+00,	4.99E+00,	-6.35E+00,	3.03E+00,	-1.01E+01,	-1.17E+01,	3.76E+00,	18.0,	0.03,	0.00,	0.34,	0.08
43,	-3.86E-01,	3.96E+00,	5.85E+00,	-4.32E-01,	-8.55E+00,	-1.26E+01,	-3.49E+01,	1.08E+01,	18.0,	0.00,	0.00,	0.01,	0.22
47,	-8.70E-01,	4.18E+00,	-5.72E+00,	5.06E-01,	-9.44E+00,	-1.25E+01,	-3.85E+01,	-1.13E+01,	18.0,	0.00,	0.00,	0.01,	0.24
48,	8.33E+00,	4.97E+00,	-4.62E+00,	6.98E+00,	2.83E+00,	-1.01E+01,	-1.26E+01,	-3.31E+00,	18.0,	0.03,	0.00,	0.37,	0.08
49,	1.20E+01,	2.88E+00,	-7.45E-01,	-1.25E+01,	-1.40E+00,	-9.78E+00,	-1.21E+01,	1.83E+00,	18.0,	0.11,	0.00,	0.66,	0.04
50,	-4.08E+00,	-4.01E+00,	3.85E-01,	-5.51E+00,	2.36E-01,	-9.19E+00,	-1.16E+01,	1.55E+00,	18.0,	0.00,	0.00,	0.16,	0.01
51,	-8.60E+00,	-6.35E+00,	-4.99E-03,	-4.01E-03,	-2.37E-01,	-8.20E+00,	-1.18E+01,	-3.32E-01,	18.0,	0.06,	0.00,	0.00,	0.01
52,	-3.45E+00,	-3.96E+00,	-2.38E-01,	5.77E+00,	4.49E-01,	-7.20E+00,	-1.12E+01,	-2.82E+00,	18.0,	0.00,	0.00,	0.16,	0.01
53,	1.39E+01,	3.20E+00,	1.11E+00,	1.34E+01,	-9.74E-01,	-5.77E+00,	-9.80E+00,	-2.67E+00,	17.9,	0.19,	0.00,	0.71,	0.03
54,	1.52E+01,	4.17E+00,	5.82E+00,	-1.05E+01,	3.09E-01,	-6.83E+00,	-1.46E+01,	1.00E+01,	18.1,	0.21,	0.00,	0.55,	0.01
55,	3.45E+00,	-7.05E-01,	7.01E+00,	-3.00E+00,	-1.04E+01,	-2.69E+00,	-2.08E+01,	5.26E+00,	18.0,	0.03,	0.00,	0.16,	0.28
59,	3.59E+00,	-1.10E+00,	-6.40E+00,	4.17E+00,	-9.45E+00,	-2.44E+00,	-1.86E+01,	-4.70E+00,	18.0,	0.04,	0.00,	0.22,	0.26
60,	1.55E+01,	4.04E+00,	-5.60E+00,	1.08E+01,	1.35E+00,	-7.69E+00,	-1.34E+01,	-8.30E+00,	18.1,	0.20,	0.00,	0.57,	0.04
61,	1.33E+01,	3.29E+00,	-7.87E-01,	-1.30E+01,	-1.32E+00,	-6.02E+00,	-1.01E+01,	3.03E+00,	18.0,	0.18,	0.00,	0.68,	0.04
62,	-3.40E+00,	-3.83E+00,	3.11E-01,	-5.88E+00,	3.12E-01,	-7.66E+00,	-1.15E+01,	2.84E+00,	18.0,	0.00,	0.00,	0.17,	0.01
63,	-8.54E+00,	-6.33E+00,	4.23E-02,	-2.40E-01,	-2.21E-01,	-8.48E+00,	-1.20E+01,	2.91E-01,	18.0,	0.06,	0.00,	0.01,	0.01
64,	-3.75E+00,	-4.14E+00,	-2.14E-01,	5.51E+00,	4.67E-01,	-9.35E+00,	-1.19E+01,	-1.55E+00,	18.0,	0.00,	0.00,	0.16,	0.01
65,	1.31E+01,	2.88E+00,	1.12E+00,	1.31E+01,	-8.27E-01,	-8.66E+00,	-1.16E+01,	-8.25E-01,	18.0,	0.13,	0.00,	0.69,	0.02

126	1.01E+01	4.00E+00	6.28E-01	-1.57E+01	1.56E-01	-1.61E+01	-9.26E+00	-2.45E+00	18.1	0.16	0.00	0.02	0.00
127	-6.02E+00	-4.39E+00	-7.99E-02	-9.74E+00	6.20E-02	-1.60E+01	-5.29E+00	-2.66E+00	18.0	0.00	0.02	0.27	0.00
128	-2.01E+01	-8.46E+00	-8.54E-01	-4.47E+00	-6.03E-02	-1.76E+01	-3.36E+00	-9.98E-01	18.0	0.18	0.12	0.24	0.00
129	-2.64E+01	-9.88E+00	1.64E-01	-1.15E-01	-6.99E-02	-1.73E+01	-3.66E+00	2.51E-01	17.9	0.32	0.14	0.01	0.00
130	-2.04E+01	-8.69E+00	9.22E-01	4.98E+00	-1.10E-01	-1.78E+01	-3.79E+00	1.48E+00	18.0	0.19	0.12	0.27	0.01
131	-5.52E+00	-4.18E+00	4.18E-03	9.54E+00	-1.46E-01	-1.66E+01	-5.19E+00	2.79E+00	18.0	0.00	0.01	0.26	0.01
132	1.80E+01	4.08E+00	-7.67E-01	1.53E+01	1.25E-01	-1.58E+01	-8.67E+00	2.44E+00	18.0	0.16	0.00	0.80	0.00
133	2.01E+01	5.77E+00	-1.39E+00	-1.28E+01	-2.30E-01	-1.90E+01	-1.00E+01	7.17E-01	18.0	0.17	0.00	0.67	0.01
134	1.04E+00	7.64E-02	-1.07E+00	-6.24E+00	1.19E+00	-1.91E+01	-7.95E+00	3.58E-01	18.0	0.00	0.00	0.17	0.03
135	-5.10E+00	-1.82E+00	5.33E-02	-6.88E-03	1.40E+00	-1.89E+01	-7.25E+00	6.46E-01	18.0	0.00	0.00	0.00	0.04
136	8.45E-01	2.17E-02	1.11E+00	6.19E+00	1.06E+00	-1.87E+01	-8.17E+00	8.87E-01	18.0	0.00	0.00	0.17	0.03
137	1.93E+01	5.53E+00	1.35E+00	1.25E+01	-2.70E-01	-1.86E+01	-1.07E+01	4.00E-01	18.0	0.15	0.00	0.66	0.01
138	1.74E+01	3.95E+00	6.46E-01	-1.51E+01	2.76E-01	-1.56E+01	-9.44E+00	-2.28E+00	18.0	0.15	0.00	0.79	0.01
139	-5.93E+00	-4.09E+00	5.61E-02	-9.33E+00	2.29E-01	-1.65E+01	-5.63E+00	-2.70E+00	18.0	0.00	0.01	0.26	0.01
140	-1.94E+01	-8.00E+00	-5.89E-01	-4.19E+00	6.87E-02	-1.74E+01	-3.65E+00	-1.13E+00	18.0	0.17	0.11	0.23	0.00
141	-2.51E+01	-9.45E+00	3.76E-01	-3.55E-04	-2.09E-02	-1.71E+01	-3.88E+00	1.51E-01	18.0	0.29	0.13	0.00	0.00
142	-1.90E+01	-8.33E+00	8.08E-01	4.75E+00	-6.52E-02	-1.76E+01	-4.05E+00	1.43E+00	18.0	0.16	0.11	0.26	0.00
143	-4.98E+00	-3.98E+00	-2.51E-01	9.04E+00	-7.88E-02	-1.63E+01	-5.50E+00	2.62E+00	18.0	0.00	0.01	0.25	0.00
144	1.73E+01	3.93E+00	-9.34E-01	1.46E+01	3.19E-01	-1.55E+01	-8.89E+00	2.07E+00	18.0	0.15	0.00	0.76	0.01
145	1.88E+01	5.82E+00	-1.18E+00	-1.11E+01	-5.29E-01	-1.68E+01	-7.90E+00	2.56E-01	18.0	0.16	0.01	0.59	0.03
146	2.03E+00	9.85E-01	-1.03E+00	-5.39E+00	8.25E-01	-1.72E+01	-7.11E+00	-2.49E-01	18.0	0.00	0.00	0.15	0.02
147	-3.29E+00	-5.54E-01	7.82E-02	1.77E-01	1.10E+00	-1.75E+01	-6.69E+00	-1.42E-01	18.0	0.00	0.00	0.00	0.03
148	2.51E+00	1.11E+00	1.09E+00	5.70E+00	6.44E-01	-1.77E+01	-7.16E+00	5.89E-02	18.0	0.00	0.00	0.16	0.02
149	1.95E+01	5.99E+00	1.09E+00	1.13E+01	-5.85E-01	-1.76E+01	-8.44E+00	-2.90E-01	18.0	0.17	0.01	0.59	0.03
150	1.69E+01	4.20E+00	-2.04E-01	-1.47E+01	-2.55E-01	-1.41E+01	-7.13E+00	-1.82E+00	18.0	0.16	0.00	0.77	0.01
151	-6.43E+00	-3.59E+00	-6.95E-01	-9.34E+00	3.18E-01	-1.50E+01	-5.15E+00	-1.88E+00	18.0	0.00	0.00	0.26	0.02
152	-1.99E+01	-8.06E+00	-6.17E-01	-4.44E+00	6.79E-01	-1.55E+01	-3.94E+00	-8.28E-01	18.0	0.20	0.10	0.24	0.04
153	-2.47E+01	-9.61E+00	8.04E-02	-1.21E-01	8.36E-01	-1.53E+01	-3.66E+00	1.44E-01	18.0	0.30	0.14	0.01	0.05
154	-2.01E+01	-8.27E+00	7.28E-01	4.63E+00	8.01E-01	-1.53E+01	-4.04E+00	1.20E+00	18.0	0.21	0.11	0.25	0.04
155	-6.31E+00	-3.64E+00	6.80E-01	9.40E+00	2.85E-01	-1.49E+01	-5.11E+00	2.02E+00	18.0	0.00	0.01	0.26	0.02
156	1.66E+01	4.15E+00	1.02E-01	1.45E+01	-2.70E-01	-1.40E+01	-6.72E+00	1.86E+00	18.0	0.15	0.00	0.76	0.01
157	1.97E+01	6.10E+00	-1.11E+00	-1.13E+01	-5.41E-01	-1.76E+01	-8.01E+00	7.27E-01	18.0	0.17	0.02	0.60	0.03
158	2.53E+00	1.15E+00	-1.03E+00	-5.59E+00	7.67E-01	-1.76E+01	-7.09E+00	3.40E-01	18.0	0.00	0.00	0.15	0.02
159	-3.20E+00	-5.02E-01	4.54E-02	-2.10E-02	1.08E+00	-1.76E+01	-6.74E+00	4.93E-01	18.0	0.00	0.00	0.00	0.03
160	2.22E+00	1.06E+00	1.06E+00	5.51E+00	6.53E-01	-1.73E+01	-7.27E+00	6.08E-01	18.0	0.00	0.00	0.15	0.02
161	1.86E+01	5.79E+00	1.09E+00	1.09E+01	-5.82E-01	-1.69E+01	-8.32E+00	5.82E-02	18.0	0.16	0.01	0.58	0.03
162	1.62E+01	4.21E+00	-9.57E-02	-1.41E+01	-1.90E-01	-1.35E+01	-7.06E+00	-1.63E+00	18.1	0.15	0.00	0.74	0.01
163	-6.19E+00	-3.22E+00	-5.10E-01	-8.97E+00	3.12E-01	-1.45E+01	-5.35E+00	-1.83E+00	18.0	0.00	0.00	0.25	0.02
164	-1.91E+01	-7.51E+00	-4.20E-01	-4.25E+00	6.25E-01	-1.51E+01	-4.18E+00	-8.69E-01	18.0	0.19	0.09	0.23	0.03
165	-2.36E+01	-9.06E+00	1.77E-01	-9.35E-02	7.52E-01	-1.50E+01	-3.89E+00	7.43E-02	18.0	0.28	0.12	0.01	0.04
166	-1.90E+01	-7.78E+00	6.22E-01	4.46E+00	7.14E-01	-1.51E+01	-4.26E+00	1.11E+00	18.0	0.19	0.09	0.24	0.04
167	-5.81E+00	-3.33E+00	4.40E-01	9.00E+00	2.42E-01	-1.46E+01	-5.30E+00	1.84E+00	18.0	0.00	0.00	0.25	0.01
168	1.61E+01	4.11E+00	-1.01E-01	1.38E+01	-1.34E-01	-1.37E+01	-6.74E+00	1.55E+00	18.0	0.15	0.00	0.73	0.01
169	1.78E+01	5.69E+00	-8.80E-01	-9.51E+00	-6.19E-01	-1.51E+01	-6.26E+00	4.79E-01	18.0	0.16	0.03	0.50	0.03
170	3.25E+00	1.60E+00	-8.90E-01	-4.68E+00	4.97E-01	-1.54E+01	-6.09E+00	9.85E-02	18.0	0.00	0.00	0.13	0.01
171	-1.50E+00	2.80E-01	6.27E-02	1.25E-01	8.15E-01	-1.56E+01	-5.97E+00	5.22E-02	18.0	0.00	0.00	0.00	0.02
172	3.50E+00	1.65E+00	9.31E-01	4.90E+00	3.69E-01	-1.56E+01	-6.26E+00	4.63E-02	18.0	0.00	0.00	0.14	0.01
173	1.81E+01	5.74E+00	7.86E-01	9.60E+00	-6.60E-01	-1.55E+01	-6.76E+00	-3.16E-01	18.0	0.16	0.03	0.51	0.04
174	1.53E+01	4.15E+00	-7.21E-01	-1.32E+01	-5.16E-01	-1.20E+01	-5.52E+00	-1.21E+00	18.0	0.15	0.01	0.69	0.03
175	-6.22E+00	-2.72E+00	-1.16E+00	-8.60E+00	4.35E-01	-1.26E+01	-4.67E+00	-1.25E+00	18.0	0.00	0.00	0.24	0.01
176	-1.89E+01	-6.83E+00	-7.63E-01	-4.23E+00	1.07E+00	-1.31E+01	-3.95E+00	-6.38E-01	18.0	0.21	0.08	0.23	0.06
177	-2.32E+01	-8.23E+00	4.64E-02	-4.96E-02	1.29E+00	-1.32E+01	-3.68E+00	9.89E-02	18.0	0.29	0.11	0.00	0.07
178	-1.90E+01	-6.91E+00	8.52E-01	4.28E+00	1.13E+00	-1.30E+01	-3.94E+00	8.74E-01	18.0	0.21	0.08	0.23	0.06
179	-6.30E+00	-2.77E+00	1.18E+00	8.67E+00	4.53E-01	-1.26E+01	-4.62E+00	1.40E+00	18.0	0.00	0.00	0.24	0.02
180	1.49E+01	4.07E+00	6.69E-01	1.31E+01	-4.97E-01	-1.19E+01	-5.26E+00	1.29E+00	18.0	0.14	0.01	0.69	0.03

236,	-1.58E+01,	-3.98E+00,	-5.73E-01,	-3.42E+00,	9.24E-01,	-8.54E+00,	-3.09E+00,	-2.44E-01,	18.0,	0.20,	0.04,	0.18,	0.05
237,	-1.94E+01,	-4.91E+00,	7.82E-02,	-1.61E-02,	1.08E+00,	-8.59E+00,	-3.04E+00,	3.22E-02,	18.0,	0.27,	0.05,	0.00,	0.06
238,	-1.59E+01,	-4.00E+00,	7.02E-01,	3.40E+00,	8.78E-01,	-8.53E+00,	-3.07E+00,	3.19E-01,	18.0,	0.20,	0.04,	0.18,	0.05
239,	-5.52E+00,	-1.22E+00,	1.00E+00,	6.79E+00,	2.74E-01,	-8.43E+00,	-3.17E+00,	4.71E-01,	18.0,	0.00,	0.00,	0.37,	0.01
240,	1.15E+01,	3.55E+00,	6.63E-01,	1.00E+01,	-5.72E-01,	-8.30E+00,	-3.24E+00,	4.83E-01,	17.9,	0.12,	0.03,	0.53,	0.03
241,	1.47E+01,	3.93E+00,	-3.43E-01,	-5.62E+00,	-7.20E-01,	-9.46E+00,	-3.37E+00,	1.32E-01,	18.0,	0.17,	0.03,	0.30,	0.04
242,	4.94E+00,	1.36E+00,	-1.26E-01,	-2.88E+00,	-2.97E-01,	-9.13E+00,	-3.00E+00,	7.23E-02,	18.0,	0.00,	0.00,	0.08,	0.01
243,	1.46E+00,	5.67E-01,	9.75E-02,	1.95E-02,	-2.04E-01,	-9.05E+00,	-3.07E+00,	9.14E-02,	18.0,	0.00,	0.00,	0.00,	0.01
244,	4.48E+00,	1.21E+00,	2.05E-01,	2.89E+00,	-5.45E-01,	-9.07E+00,	-3.02E+00,	7.03E-02,	18.0,	0.00,	0.00,	0.08,	0.02
245,	1.37E+01,	3.69E+00,	6.99E-02,	5.58E+00,	-8.42E-01,	-9.46E+00,	-3.40E+00,	-1.07E-01,	18.0,	0.15,	0.03,	0.30,	0.05
246,	1.15E+01,	3.27E+00,	-5.40E-01,	-8.69E+00,	-6.46E-01,	-6.82E+00,	-2.65E+00,	-4.60E-01,	18.0,	0.13,	0.03,	0.46,	0.04
247,	-4.94E+00,	-7.98E-01,	-4.52E-01,	-5.92E+00,	7.05E-02,	-6.66E+00,	-2.36E+00,	-4.38E-01,	18.0,	0.01,	0.00,	0.32,	0.00
248,	-1.52E+01,	-3.01E+00,	-2.37E-01,	-2.96E+00,	4.66E-01,	-6.76E+00,	-2.40E+00,	-2.35E-01,	18.0,	0.21,	0.03,	0.16,	0.03
249,	-1.87E+01,	-3.77E+00,	1.14E-01,	5.04E-02,	5.73E-01,	-6.81E+00,	-2.40E+00,	5.51E-03,	18.0,	0.27,	0.04,	0.00,	0.03
250,	-1.54E+01,	-3.11E+00,	4.43E-01,	3.05E+00,	3.80E-01,	-6.75E+00,	-2.38E+00,	2.37E-01,	18.0,	0.21,	0.03,	0.16,	0.02
251,	-5.59E+00,	-1.00E+00,	5.32E-01,	5.95E+00,	-2.09E-01,	-6.63E+00,	-2.26E+00,	4.28E-01,	18.0,	0.02,	0.00,	0.32,	0.01
252,	1.04E+01,	2.99E+00,	3.32E-01,	8.64E+00,	-7.77E-01,	-6.82E+00,	-2.49E+00,	5.42E-01,	18.0,	0.11,	0.03,	0.46,	0.04
253,	1.49E+01,	3.98E+00,	-3.06E-01,	-5.65E+00,	-7.34E-01,	-9.46E+00,	-3.40E+00,	1.26E-01,	18.0,	0.17,	0.03,	0.30,	0.04
254,	5.10E+00,	1.39E+00,	-1.22E-01,	-2.94E+00,	-3.21E-01,	-9.12E+00,	-3.03E+00,	4.60E-02,	18.0,	0.00,	0.00,	0.08,	0.01
255,	1.48E+00,	5.65E-01,	8.07E-02,	-4.21E-02,	-2.04E-01,	-9.04E+00,	-3.08E+00,	5.47E-02,	18.0,	0.00,	0.00,	0.00,	0.01
256,	4.36E+00,	1.18E+00,	1.97E-01,	2.83E+00,	-5.24E-01,	-9.06E+00,	-3.00E+00,	3.50E-02,	18.0,	0.00,	0.00,	0.08,	0.02
257,	1.34E+01,	3.63E+00,	9.32E-02,	5.54E+00,	-8.25E-01,	-9.45E+00,	-3.36E+00,	-1.22E-01,	18.0,	0.14,	0.03,	0.30,	0.04
258,	1.13E+01,	3.19E+00,	-4.48E-01,	-8.64E+00,	-5.85E-01,	-6.76E+00,	-2.62E+00,	-4.31E-01,	18.0,	0.13,	0.03,	0.46,	0.03
259,	-4.93E+00,	-8.56E-01,	-3.35E-01,	-5.87E+00,	7.99E-02,	-6.58E+00,	-2.35E+00,	-3.95E-01,	18.0,	0.01,	0.00,	0.32,	0.00
260,	-1.50E+01,	-3.06E+00,	-1.63E-01,	-2.93E+00,	4.58E-01,	-6.64E+00,	-2.41E+00,	-2.05E-01,	18.0,	0.20,	0.03,	0.16,	0.02
261,	-1.84E+01,	-3.81E+00,	1.17E-01,	5.28E-02,	5.61E-01,	-6.68E+00,	-2.42E+00,	1.04E-02,	18.0,	0.27,	0.04,	0.00,	0.03
262,	-1.52E+01,	-3.15E+00,	3.72E-01,	3.02E+00,	3.73E-01,	-6.63E+00,	-2.40E+00,	2.14E-01,	18.0,	0.21,	0.03,	0.16,	0.02
263,	-5.53E+00,	-1.06E+00,	4.13E-01,	5.90E+00,	-2.00E-01,	-6.54E+00,	-2.27E+00,	3.87E-01,	18.0,	0.02,	0.00,	0.32,	0.01
264,	1.03E+01,	2.92E+00,	2.27E-01,	8.59E+00,	-7.12E-01,	-6.75E+00,	-2.47E+00,	5.01E-01,	18.0,	0.11,	0.02,	0.46,	0.04
265,	4.41E+00,	1.57E+00,	-1.08E-02,	-2.18E+00,	-4.51E-01,	-4.32E+00,	-1.92E+00,	2.87E-01,	12.0,	0.08,	0.02,	0.20,	0.04
266,	1.55E+00,	6.39E-01,	-4.66E-02,	-1.17E+00,	-3.66E-01,	-4.68E+00,	-2.43E+00,	1.67E-01,	12.0,	0.00,	0.00,	0.06,	0.02
267,	5.17E-01,	2.09E-01,	-9.13E-03,	-1.16E-02,	-1.97E-01,	-4.73E+00,	-2.44E+00,	1.28E-01,	12.0,	0.00,	0.00,	0.00,	0.01
268,	1.36E+00,	5.21E-01,	3.58E-02,	1.12E+00,	-2.46E-01,	-4.61E+00,	-2.44E+00,	8.31E-02,	12.0,	0.00,	0.00,	0.05,	0.01
269,	4.02E+00,	1.40E+00,	4.82E-02,	2.18E+00,	-3.46E-01,	-4.20E+00,	-1.93E+00,	-5.21E-02,	12.0,	0.07,	0.02,	0.20,	0.03
270,	3.34E+00,	1.05E+00,	-1.42E-01,	-3.49E+00,	-4.40E-01,	-2.83E+00,	-1.53E+00,	-1.64E-01,	12.0,	0.07,	0.01,	0.31,	0.04
271,	-1.65E+00,	-8.52E-01,	-2.10E-01,	-2.46E+00,	-7.85E-02,	-3.34E+00,	-1.96E+00,	-1.61E-01,	12.0,	0.01,	0.00,	0.22,	0.01
272,	-4.77E+00,	-2.23E+00,	-1.52E-01,	-1.24E+00,	3.26E-01,	-3.48E+00,	-1.90E+00,	-7.92E-02,	12.0,	0.10,	0.04,	0.11,	0.03
273,	-5.86E+00,	-2.75E+00,	-1.15E-03,	2.10E-02,	4.85E-01,	-3.52E+00,	-1.87E+00,	3.86E-02,	12.0,	0.14,	0.06,	0.00,	0.04
274,	-4.88E+00,	-2.32E+00,	1.46E-01,	1.26E+00,	3.87E-01,	-3.47E+00,	-1.88E+00,	1.73E-01,	12.0,	0.11,	0.05,	0.11,	0.04
275,	-1.91E+00,	-1.02E+00,	2.07E-01,	2.44E+00,	8.93E-02,	-3.28E+00,	-1.89E+00,	2.92E-01,	12.0,	0.01,	0.01,	0.22,	0.01
276,	2.94E+00,	8.68E-01,	1.98E-01,	3.51E+00,	-2.43E-01,	-2.75E+00,	-1.44E+00,	2.75E-01,	12.0,	0.05,	0.01,	0.31,	0.02
277,	4.45E+00,	1.59E+00,	6.03E-04,	-2.19E+00,	-4.60E-01,	-4.29E+00,	-1.93E+00,	2.81E-01,	12.0,	0.08,	0.02,	0.20,	0.04
278,	1.59E+00,	6.52E-01,	-4.59E-02,	-1.19E+00,	-3.81E-01,	-4.67E+00,	-2.45E+00,	1.52E-01,	12.0,	0.00,	0.00,	0.06,	0.02
279,	5.23E-01,	2.10E-01,	-1.48E-02,	-3.05E-02,	-1.99E-01,	-4.72E+00,	-2.44E+00,	1.04E-01,	12.0,	0.00,	0.00,	0.00,	0.01
280,	1.33E+00,	5.09E-01,	3.31E-02,	1.11E+00,	-2.35E-01,	-4.62E+00,	-2.43E+00,	6.40E-02,	12.0,	0.00,	0.00,	0.05,	0.01
281,	3.98E+00,	1.39E+00,	5.50E-02,	2.18E+00,	-3.35E-01,	-4.23E+00,	-1.93E+00,	-5.00E-02,	12.0,	0.07,	0.02,	0.20,	0.03
282,	3.30E+00,	1.02E+00,	-1.18E-01,	-3.49E+00,	-4.11E-01,	-2.83E+00,	-1.52E+00,	-1.55E-01,	12.0,	0.07,	0.01,	0.31,	0.04
283,	-1.66E+00,	-8.85E-01,	-1.80E-01,	-2.46E+00,	-6.96E-02,	-3.31E+00,	-1.95E+00,	-1.46E-01,	12.0,	0.01,	0.00,	0.22,	0.01
284,	-4.74E+00,	-2.26E+00,	-1.32E-01,	-1.23E+00,	3.22E-01,	-3.44E+00,	-1.90E+00,	-6.64E-02,	12.0,	0.10,	0.04,	0.11,	0.03
285,	-5.81E+00,	-2.77E+00,	3.90E-05,	2.06E-02,	4.75E-01,	-3.47E+00,	-1.88E+00,	4.17E-02,	12.0,	0.14,	0.06,	0.00,	0.04
286,	-4.85E+00,	-2.35E+00,	1.27E-01,	1.26E+00,	3.80E-01,	-3.42E+00,	-1.89E+00,	1.64E-01,	12.0,	0.11,	0.05,	0.11,	0.03
287,	-1.90E+00,	-1.04E+00,	1.75E-01,	2.43E+00,	9.29E-02,	-3.25E+00,	-1.89E+00,	2.75E-01,	12.0,	0.02,	0.01,	0.22,	0.01
288,	2.91E+00,	8.43E-01,	1.71E-01,	3.51E+00,	-2.12E-01,	-2.73E+00,	-1.45E+00,	2.57E-01,	12.0,	0.05,	0.01,	0.31,	0.02
289,	3.95E+00,	1.16E+00,	-5.99E-02,	-1.71E+00,	-2.76E-01,	-3.31E+00,	-1.47E+00,	3.25E-01,	12.0,	0.08,	0.02,	0.15,	0.02
290,	1.49E+00,	3.19E-01,	-1.71E-01,	-8.17E-01,	3.21E-02,	-3.31E+00,	-1.66E+00,	2.53E-01,	12.0,	0.00,	0.00,	0.07,	0.00

346,	-3.42E+00,	-1.88E-01,	1.33E-01,	6.75E-01,	1.69E-01,	-4.02E-01,	-2.67E-01,	1.57E-02,	12.0,	0.10,	0.00,	0.06, 0.02
347,	-1.35E+00,	2.29E-03,	1.03E-01,	1.19E+00,	-6.48E-02,	-3.41E-01,	-1.86E-01,	9.33E-02,	12.0,	0.04,	0.00,	0.11, 0.00
348,	1.59E+00,	4.05E-01,	1.34E-01,	1.35E+00,	-3.15E-01,	-1.57E-01,	-2.69E-01,	2.75E-01,	12.0,	0.05,	0.01,	0.12, 0.03
349,	2.95E+00,	5.31E-01,	-2.60E-01,	-3.80E-01,	-4.38E-01,	-9.83E-01,	-6.09E-01,	6.00E-02,	12.0,	0.08,	0.01,	0.03, 0.04
350,	1.82E+00,	1.42E-01,	-1.63E-01,	-3.36E-01,	-4.74E-02,	-8.51E-01,	-2.49E-01,	1.13E-02,	12.0,	0.05,	0.00,	0.03, 0.00
351,	1.26E+00,	5.40E-02,	2.45E-02,	-2.64E-02,	5.95E-03,	-7.89E-01,	-2.73E-01,	-6.56E-03,	12.0,	0.03,	0.00,	0.00, 0.00
352,	1.60E+00,	1.30E-01,	1.71E-01,	2.85E-01,	-1.45E-01,	-8.15E-01,	-2.42E-01,	-2.52E-02,	12.0,	0.04,	0.00,	0.03, 0.01
353,	2.58E+00,	4.99E-01,	1.82E-01,	3.60E-01,	-3.11E-01,	-9.41E-01,	-5.51E-01,	-5.17E-02,	12.0,	0.07,	0.01,	0.03, 0.03
354,	1.95E+00,	5.16E-01,	-2.05E-01,	-1.35E+00,	-3.57E-01,	-2.02E-01,	-3.24E-01,	-2.14E-01,	12.0,	0.06,	0.01,	0.12, 0.03
355,	-1.07E+00,	1.11E-02,	-1.53E-01,	-1.18E+00,	9.64E-02,	-3.66E-01,	-1.91E-01,	-1.00E-01,	12.0,	0.03,	0.00,	0.11, 0.00
356,	-3.28E+00,	-1.79E-01,	-4.25E-02,	-6.51E-01,	2.41E-01,	-4.14E-01,	-2.61E-01,	-2.86E-02,	12.0,	0.10,	0.00,	0.06, 0.02
357,	-4.10E+00,	-2.41E-01,	4.98E-02,	1.65E-02,	2.55E-01,	-4.21E-01,	-2.79E-01,	-5.82E-03,	12.0,	0.12,	0.00,	0.00, 0.02
358,	-3.41E+00,	-1.91E-01,	1.28E-01,	6.77E-01,	1.71E-01,	-4.10E-01,	-2.67E-01,	1.67E-02,	12.0,	0.10,	0.00,	0.06, 0.02
359,	-1.35E+00,	-1.96E-05,	1.75E-01,	1.19E+00,	-6.34E-02,	-3.47E-01,	-1.85E-01,	9.49E-02,	12.0,	0.04,	0.00,	0.11, 0.00
360,	1.59E+00,	4.03E-01,	1.27E-01,	1.35E+00,	-3.08E-01,	-1.58E-01,	-2.67E-01,	2.78E-01,	12.0,	0.05,	0.01,	0.12, 0.03
400,	-4.22E+00,	-6.20E+00,	-2.47E+00,	1.91E+00,	9.64E-01,	2.59E-01,	-1.72E-01,	2.34E-02,	18.0,	0.08,	0.11,	0.10, 0.05
401,	-7.37E-01,	-9.16E+00,	-2.38E+00,	3.60E-01,	9.12E+00,	1.28E-01,	-1.25E-01,	5.25E-02,	18.0,	0.02,	0.17,	0.02, 0.48
402,	1.28E-01,	-1.06E+01,	-8.25E-02,	4.32E-01,	1.21E+01,	1.55E-01,	-1.70E-01,	6.46E-02,	18.0,	0.00,	0.20,	0.02, 0.64
403,	-2.62E-01,	-9.08E+00,	2.30E+00,	3.77E-01,	9.21E+00,	1.38E-02,	-2.51E-01,	9.87E-02,	18.0,	0.01,	0.17,	0.02, 0.49
404,	-4.56E+00,	-6.29E+00,	2.42E+00,	-2.96E+00,	1.54E+00,	-5.46E-01,	6.31E-02,	1.30E-01,	18.0,	0.08,	0.12,	0.16, 0.08
405,	-6.08E+00,	-2.86E+00,	-3.43E+00,	1.03E+01,	9.44E-01,	-6.06E-01,	6.58E-01,	-3.76E-02,	18.0,	0.11,	0.06,	0.54, 0.08
406,	5.74E+00,	2.36E+00,	-2.59E+00,	3.44E+00,	5.07E+00,	1.26E-01,	2.76E-01,	-2.13E-01,	18.0,	0.11,	0.05,	0.18, 0.26
407,	8.63E+00,	4.07E+00,	-2.79E-02,	1.06E-01,	6.26E+00,	2.42E-01,	8.95E-02,	-1.88E-01,	18.0,	0.16,	0.08,	0.01, 0.32
408,	5.96E+00,	2.72E+00,	2.50E+00,	-3.32E+00,	4.87E+00,	1.10E-01,	2.72E-01,	-1.79E-01,	18.0,	0.11,	0.05,	0.17, 0.25
409,	-5.69E+00,	-2.35E+00,	3.26E+00,	-1.05E+01,	8.47E-01,	-6.34E-01,	5.87E-01,	-2.22E-02,	17.9,	0.10,	0.05,	0.56, 0.04
410,	-2.15E+00,	2.20E+00,	-2.45E+00,	1.11E+01,	5.33E+00,	-1.11E-01,	-3.37E-01,	1.31E-01,	18.0,	0.04,	0.04,	0.58, 0.28
411,	1.03E+01,	9.72E+00,	-1.09E+00,	4.09E+00,	4.13E+00,	3.11E-03,	-1.41E-01,	3.17E-02,	18.0,	0.19,	0.18,	0.21, 0.22
412,	1.35E+01,	1.18E+01,	3.92E-02,	-4.21E-02,	3.53E+00,	7.00E-02,	-4.07E-02,	-2.39E-02,	18.0,	0.26,	0.22,	0.00, 0.19
413,	1.00E+01,	9.61E+00,	1.17E+00,	-4.26E+00,	4.10E+00,	1.11E-01,	3.41E-02,	-4.19E-02,	18.0,	0.19,	0.18,	0.22, 0.21
414,	-2.21E+00,	2.01E+00,	2.19E+00,	-9.71E+00,	4.13E+00,	1.97E-01,	1.74E-01,	-8.42E-02,	18.0,	0.04,	0.04,	0.50, 0.21
415,	3.85E+00,	1.25E+01,	2.30E-01,	4.68E+00,	-2.50E-01,	5.97E-01,	-6.02E-01,	4.47E-02,	18.0,	0.08,	0.23,	0.24, 0.01
416,	1.21E+01,	1.36E+01,	7.14E-02,	3.42E+00,	2.86E-01,	7.91E-03,	-3.50E-01,	1.50E-01,	18.0,	0.23,	0.25,	0.18, 0.02
417,	1.51E+01,	1.49E+01,	1.23E-01,	2.17E-03,	-1.15E-02,	-8.17E-02,	-1.84E-01,	1.27E-01,	18.0,	0.28,	0.28,	0.00, 0.00
418,	1.21E+01,	1.36E+01,	1.04E-01,	-3.41E+00,	-3.35E-01,	-4.74E-03,	-3.64E-01,	1.60E-01,	18.0,	0.23,	0.25,	0.18, 0.02
419,	3.87E+00,	1.25E+01,	3.00E-01,	-4.63E+00,	9.51E-02,	6.04E-01,	-6.36E-01,	5.63E-02,	18.0,	0.08,	0.23,	0.24, 0.01
420,	-2.29E+00,	1.82E+00,	2.23E+00,	9.78E+00,	-4.15E+00,	2.22E-01,	1.56E-01,	-8.71E-02,	18.0,	0.05,	0.04,	0.51, 0.21
421,	9.97E+00,	9.50E+00,	1.18E+00,	4.28E+00,	-4.14E+00,	1.21E-01,	3.27E-02,	-4.14E-02,	18.0,	0.19,	0.18,	0.22, 0.21
422,	1.35E+01,	1.17E+01,	3.48E-02,	5.34E-02,	-3.56E+00,	7.28E-02,	-3.23E-02,	-2.32E-02,	18.0,	0.26,	0.22,	0.00, 0.19
423,	1.03E+01,	9.64E+00,	-1.09E+00,	-4.11E+00,	-4.15E+00,	-6.71E-03,	-1.27E-01,	3.39E-02,	18.0,	0.19,	0.18,	0.22, 0.22
424,	-2.23E+00,	2.08E+00,	-2.46E+00,	-1.12E+01,	-5.32E+00,	-1.52E-01,	-3.24E-01,	1.41E-01,	18.0,	0.04,	0.03,	0.59, 0.29
425,	-5.90E+00,	-2.53E+00,	3.35E+00,	1.06E+01,	-8.10E-01,	-6.08E-01,	5.88E-01,	-3.06E-02,	18.0,	0.10,	0.05,	0.56, 0.04
426,	5.87E+00,	2.60E+00,	2.53E+00,	3.38E+00,	-4.90E+00,	1.16E-01,	2.78E-01,	-1.83E-01,	18.0,	0.11,	0.05,	0.18, 0.25
427,	8.62E+00,	4.00E+00,	-3.39E-02,	-6.54E-02,	-6.25E+00,	2.40E-01,	1.04E-01,	-1.93E-01,	18.0,	0.17,	0.08,	0.00, 0.32
428,	5.78E+00,	2.31E+00,	-2.59E+00,	-3.44E+00,	-4.99E+00,	1.16E-01,	3.05E-01,	-2.20E-01,	18.0,	0.11,	0.05,	0.18, 0.26
429,	-6.09E+00,	-2.92E+00,	-3.37E+00,	-1.03E+01,	-8.20E-01,	-6.40E-01,	7.10E-01,	-4.30E-02,	17.9,	0.11,	0.06,	0.55, 0.04
430,	-4.90E+00,	-6.45E+00,	2.54E+00,	3.06E+00,	-1.44E+00,	-5.52E-01,	9.11E-02,	1.24E-01,	18.0,	0.09,	0.12,	0.17, 0.07
431,	-4.50E-01,	-9.18E+00,	2.37E+00,	-2.48E-01,	-9.25E+00,	1.61E-02,	-2.30E-01,	9.36E-02,	18.0,	0.01,	0.17,	0.01, 0.49
432,	1.12E-01,	-1.06E+01,	-5.54E-02,	-3.05E-01,	-1.21E+01,	1.50E-01,	-1.52E-01,	6.29E-02,	18.0,	0.00,	0.20,	0.02, 0.64
433,	-6.05E-01,	-9.11E+00,	-2.36E+00,	-2.56E-01,	-9.01E+00,	1.14E-01,	-1.21E-01,	5.98E-02,	18.0,	0.01,	0.17,	0.01, 0.49
434,	-4.00E+00,	-6.15E+00,	-2.40E+00,	-1.86E+00,	-9.85E-01,	2.97E-01,	-2.05E-01,	2.48E-02,	18.0,	0.08,	0.11,	0.10, 0.05

US Army Corps of Engineers	PROJECT TITLE: CHASKA STAGE 3	COMPUTED BY: T. Fores	DATE:	SHEET: 25	28
Saint Paul District	SUBJECT TITLE: GATEWELL 'D'	CHECKED BY: JHM	DATE: 8-11-93	CONTRACT NO.:	

CHECK THE COSMOS, COMPUTER AIDED DESIGN, RESULTS!

ASSUME THE WALLS WILL ACT AS A FIXED END SLAB THEN THE MOMENT IN THE MIDDLE OF THE WALL AND JUST ABOVE THE PIPE OPENING WILL BE $\frac{w\ell^2}{14}$

$$M = \frac{(3.34)(12.5)^2}{14} = 37.28 \text{ K-FT}$$

MOMENT FROM COMPUTATION = $\underset{Mx}{32.3} + \underset{Vx}{0.426} * \frac{11.6'}{2}$ = 34.64 K-FT

SHEAR ARM

$\Rightarrow$ 37.28 > 34.64, BUT TAKING INTO CONSIDERATION THAT THE WALL WILL ACT AS A PLATE, THEN THE RESULT IS OK

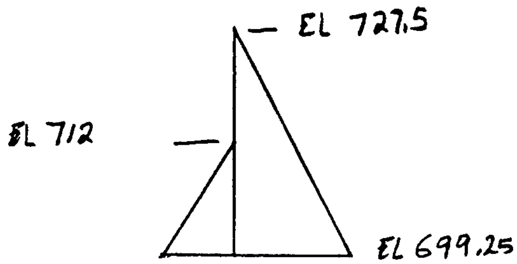
CENCS 23JAN92

US Army Corps of Engineers Saint Paul District	PROJECT TITLE: CHASKA STG 3, DM	COMPUTED BY: TONY FARES	DATE: 8/4/92	SHEET: 27	28
	SUBJECT TITLE: GATEWELL "D" STOPLOG DESIGN	CHECKED BY: JHM	DATE: 8/11/93	CONTRACT NO.:	

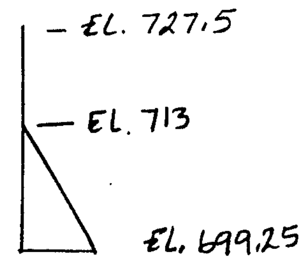
STOP LOG DESIGN

LOAD:

NORMAL



DW



$P = [(727.5 - 699.25) - (712 - 699.25)](0.0625)$ $\quad$ $P = (713.0 - 699.25)(0.0625)$

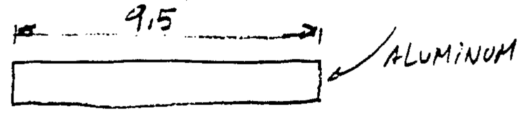
$= 0.97\ KSF$ ← GOVERNS. $\quad$ $= 0.86\ KSF$

$W_u = (1.7)(0.97) = 1.65\ KSF$

$LOAD = \frac{1.65 \times 6''}{12''} = 0.825\ K/FT$ ASSUMING 6"x4" STOPLOG

$M_u = \frac{(0.825)(9.5)^2}{12} = 6.2\ K\text{-}FT$

$= 74.41\ K\text{-}IN$



$F_b = 15\ KSI$

$S = \frac{M}{F_b} = \frac{74.41}{15} = 4.96\ IN^3$

$S = \frac{6 \times 4^3 - (6-2x)(4-2x)^3}{6(4)} = 4.96 \Rightarrow X = 0.21" \simeq \frac{1}{4}$ THICK.

~~BUT FOR EMERGENCY & DEFLECTION USE 3/16 TUBE~~

$S = \frac{6 \times 4^3 - 5.5 \times 3.5^3}{6(4)} = 6.17\ IN^3 > 4.96\ IN^3$ OK

$f = \frac{74.41}{6.17} = 12.06\ KSI < 15\ KSI$ OK

SHEAR IN WEBS.

$V = \frac{P}{2} = \frac{(1.65)(9.5)}{2} = 7.84\ Kips$

CENCS14 23JAN92

SAMPLE COMPUTATIONS

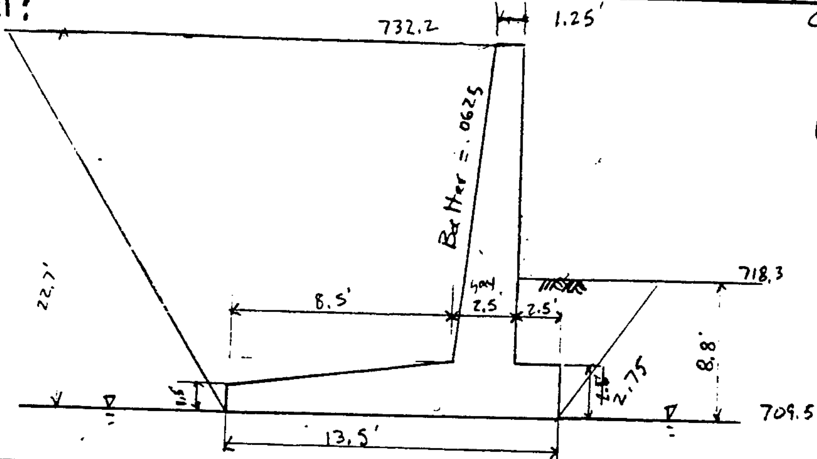
RETAINING WALL

US Army Corps of Engineers Saint Paul District	PROJECT TITLE: CHASKA STAGE 3	COMPUTED BY: JHM	DATE: 7-13-93	SHEET: 6 51
	SUBJECT TITLE: RETAINING WALL DROP STRUCTURE 1 UPSTREAM MONOLITH # 4	CHECKED BY:	DATE: 8/21/93	CONTRACT NO.:

LOAD CASE R1:

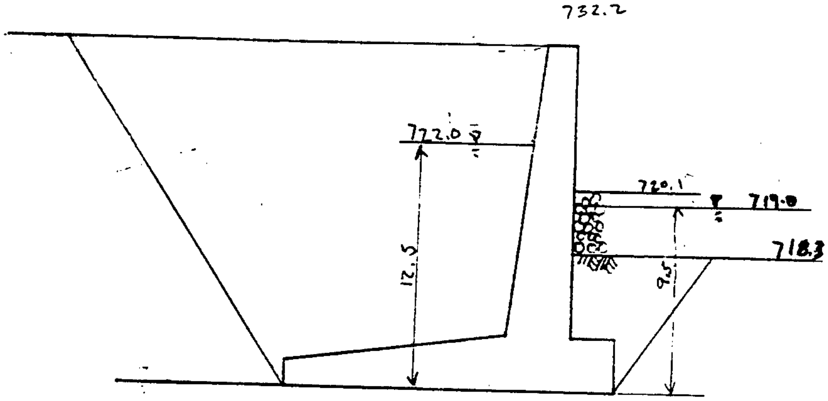
CONSTRUCTION CONDITION, No Riprap.

(USE SOIL STRAIGHT ACROSS IN BACKFILL, No SURCHARGE)



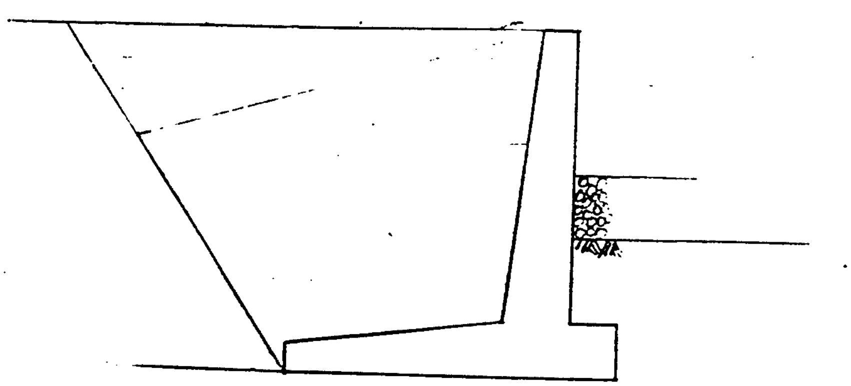
LOAD CASE R2:

DRAW DOWN, 3' Lag in water SURFACE.



LOAD CASE X:

(Not REQUIRED)



RESULTS:

R1 LOAD	% of BASE IN COMP. 100%	SLIDING SF 1.5	BEARING SF 3.0	R2 LOAD	% BASE IN COMP. 75%	SLIDING SF 1.33	BEARING SF 2.0	X LOAD	% BASE IN COMP. 60%	SLIDING SF 1.1	BEARING SF 1.01
Excess Soil	* 100%	1.81	3.83	Excess Soil	90%	1.57	2.62				

US Army Corps of Engineers Saint Paul District	PROJECT TITLE: CHASKA STAGE 3	COMPUTED BY: JHM	DATE: 7-15-93	SHEET: 8	51
	SUBJECT TITLE: DROP STRUCTURE 1 UP STREAM, MONOLITH (4)	CHECKED BY: [illegible]	DATE: 8/26/93	CONTRACT NO.:	

SLIDING STABILITY CHECK

$$FS = \frac{N' \tan\phi + cL}{\Sigma H} = \frac{33.4^k \tan 30° + 0}{11.4^k} = 1.69 \geq 1.5 \text{ Required}$$

∴ SLIDING CRITERIA IS SATISFIED

CHECK BEARING CAPACITY: $\phi = 30°$ $c = 0$

$$e = B/2 - \bar{x} = 13.5/2 - 4.53' = 2.22'$$

$$q' = P = N'/B\,(1 \pm 6e/B) = 33.4/13.5\,(1 + 6(2.22)/13.5) = 4.92 \text{ KSF (MAX)}$$
$$.03 \text{ KSF (MIN)}$$

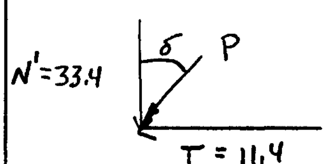
$$\bar{B} = B - 2e = 13.5 - 2(2.22) = 9.06'$$

$$q_o = \gamma_m (8.8') = .114(8.8) = 1.0 \text{ KSF}$$

FROM TABLE 5-1: $N_q = 18.4$ $N_c = 30.14$ $N_\gamma = 15.67$

$$\xi_{qd} = 1 + .1(D/\bar{B}) \tan(45 + 30°/2) = 1 + .1(8.8/9.06) \tan(60°) = 1.168$$

$$\xi_{\gamma d} = \xi_{qd} = 1.168$$



$$\delta = \tan^{-1}(T/N') = 18.85° = .33 \text{ RADIANS}$$

$$\xi_{qi} = (1 - 18.85/90)^2 = .625 \qquad \xi_{qg} = \xi_{\gamma g} = (1 - \tan\beta)^2 = 1.0$$

$$\xi_{\gamma i} = (1 - 18.85/30)^2 = .138$$

$$\xi_{qt} = \xi_{\gamma t} = 1 - (.0)(\tan 30°)^2 = 1.0$$

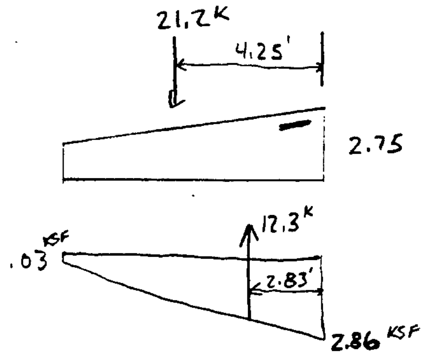
$$Q = 9.06\left[1.168(.625)(1.0)(1.0)(18.4) + 1.168(.138)(1.0)(9.06)(.114)(15.67)/2\right]$$

$$= 133.5 \text{ K/FT}$$

$$FS = Q/N' = 133.5/33.4 = 4.0 \geq 3.0 \text{ REQUIRED} \therefore \text{OK}$$

US Army Corps of Engineers Saint Paul District	PROJECT TITLE: CHASKA - STAGE 3	COMPUTED BY: JHM	DATE: 7-15-93	SHEET: 10	51
	SUBJECT TITLE: DROP STRUCTURE 1 UPSTEAM, MONOLITH 4	CHECKED BY:	DATE: [illegible]26/93	CONTRACT NO.:	

(2) IN HEEL AT FACE of STEM.



$21.2^K \times 4.25' = 90.1$ K-FT

$-12.3^K \times 2.83' = -34.8$ K-FT

8.9 K $\qquad$ 55.3 K-FT

$$\frac{M_u}{\Phi} = \frac{1.9(55.3)(12)}{.90} = 1400.9 \text{ K-IN}$$

$$K_u = 1 - \sqrt{1 - \frac{1400.9}{.425(4.0)(12)(28.5)^2}} = 0.0432$$

$$C_u = T_u = .85(4)(.0432)(12)(28.5) = 50.2 \text{ K}$$

$$A_s = \frac{50.2}{60} = 0.84 \text{ IN}^2$$

$$\rho = A_s/bd = .84/12(28.5) = .00246 < \rho_{min}$$

TRY $\frac{4}{3} A_s$ = **1.12 IN²** ← USE $< \rho_{min}$ ✓ GOOD

US ARMY CORPS OF ENGINEERS SAINT PAUL DISTRICT	PROJECT TITLE: CHASKA STAGE 3	COMPUTED BY: JHM	DATE: 07/13/93	SHEET: 12	51
	SUBJECT TITLE: DROP STRUCT. 1, ~~DS~~ US WING WALLS	CHECKED BY:	DATE:	CONTRACT NO.:	

UP STREAM WING WALL, MONOLITH NO. 4, LOAD CASE – R1

RETAINING WALL DESIGN BASED ON ENGINEER MANUAL EM 1110-2-2502
KDH Version 3

WALL SECTION PROPERTIES

TOTAL HEIGHT,VT (FT.)	22.700	HEEL DEPTH @ BACK,V8 (FT)	1.500	
FOOTING DEPTH TOE,V1 (FT.)	2.750	STEM BATTER	0.0627	.0625 ok
STEM HEIGHT,V2 (FT.)	19.950	WALL WIDTH AT TOP,H1 (FT.)	1.250	
STRAIGHT WALL HT.,V3 (FT.)	0.000	WALL WIDTH AT BOT.,H2 (FT.)	2.500	2.497 ok
SLOPED WALL HT., V4 (FT.)	19.950	WALL SLOPE,H3 (FT.)	1.250	
B.O.F. TO T.O.S., V5 (FT.)	8.800	FOOTING TOE WIDTH,H4 (FT.)	2.500	
SOIL DEPTH, V6 (FT.)	6.050	FOOTING HEEL WIDTH,H5 (FT.)	8.500	
FOOTING DEPTH HEEL, V7(FT)	2.750	FOOTING WIDTH,HT (FT.)	13.500	
		UNIT WEIGHT CONC.,(K/CUFT)	0.150	
DEPTH OF RIPRAP IN CHANNEL	0.000	UNIT WEIGHT RIPRAP,(K/CUFT)	0.135	

ADDITIONAL VERTICAL LOADS

LOADS ON BACKFILL		LOADS ON STRUCTURAL WEDGE ***	
HIGHWAY L.L. SURCHARGE	0.000 K/FT	HIGHWAY L.L. SURCHARGE	0.000 K/FT
LIVE LOAD SURCHARGE (vd)*	0.000 K/FT	LIVE LOAD SURCHARGE	0.000 K/FT
Vd =	0.000 K	SURCHARGE (Vs)**	0.000 K
SURCHARGE LOCATION S =	12.461 FT	DIST. TO F. WALL FACE	6.125 FT
(DRIVING WEDGE) X =	0.000 FT	SURCHARGE LOCATION X1=	1.250 FT
LOADS ON RESISTING WEDGE		FROM F. FACE OF WALL X2=	11.000 FT
RIPRAP (vr)**	0.000 K/FT		
		PARAPET LOAD	
		– HEIGHT	0.000 FT
		– WIDTH	0.000 FT

* A CHECK IS MADE TO DETERMINE IF THE SURCHARGE ON THE BACKFILL WILL LIE WITHIN THE INFLUENCE OF THE DRIVING WEDGE.

** IT IS CONSERVATIVE TO NEGLECT SURCHARGES Vr AND Vs. IF INCLUDED ASSURE THEY WILL STAY IN PLACE FOR THE CONDITION ANALYZED.

*** THESE LOADS ARE ASSUMED TO ACT ON THE BACKFILL SIDE OF WALL ONLY.

STABILITY REQUIREMENTS

LOADING CONDITIONS CASE ======>	R1		
% OF PASSIVE PRESSURE USED	50	SLIDING SAFETY FACTOR	1.50
MIN. BASE AREA IN COMPRESS.	100	BEARING CAP. SAFETY FACTOR	3.00

SOIL PROPERTIES (DRIVING WEDGE)

FRICTION ANGLE OF SOIL (01)	33.000 DEG.,(DRIVING WEDGE)	
FRICTION ANGLE OF SOIL (02)	33.000 DEG.,(STRUCT. WEDGE)	
SLOPE OF BACKFILL RISE/RUN	0.000	
BETA ANGLE (B1)	0.000 DEG.	
POINT AT WHICH BACKFILL SLOPE BEGINS	2.00	1=SLOPE BEGINS @ STEM
SOIL DEPTH BACK of HEEL(Hz)	22.700	2=SLOPE BEGINS@BACK OF HEEL
STR. MOBILIZATION FACTOR	0.667 (SMF)	
SOIL UNIT Wt.,MOIST (§m1)	0.1140 K/CUFT	
SOIL UNIT Wt.,SATUR. (§s1)	0.1270 K/CUFT	{ENTER §m1 IF NOT SATUR.}
SOIL UNIT Wt.,BOUYANT (§b1)	0.0645 K/CUFT	
DEPTH OF CRACK (dc)	0.000 FT.	
COHESION ON SLIP PLANE C=	0.000 KSF	
COHESION ON SLIP PLANE Cd=	0.000 KSF(DEVELOPED) =	Cd = (SMF)*C

US ARMY CORPS OF ENGINEERS SAINT PAUL DISTRICT	PROJECT TITLE: CHASKA STAGE 3	COMPUTED BY: JHM	DATE: 07/15/93	SHEET: 14	51
	SUBJECT TITLE: DROP STRUCT. 1, DS WING WALLS	CHECKED BY: ..T	DATE: 3/23/93	CONTRACT NO.:	

UP STREAM WING WALL, MONOLITH NO. 4, LOAD CASE – R1

RETAINING WALL DESIGN BASED ON ENGINEER MANUAL EM 1110-2-2502
KDH Version 3

DRIVING WEDGE PROPERTIES

SLIP-PLANE ANGLE WITHOUT SURCHARGE

0d=ARCTAN(SMF*TAN0) = 23.41 DEG.

A= TAN0d+ 2*Cd(1-TAN0dTANB1) / $m1(Hz+dc) - 2*V(1+TAN0d^2) / $m1(Hz^2-dc^2) = 0.4329 EQU. 3-30

C1=[2*TAN0d^2 + 4*Cd(TAN0d+TANB1) / $m1(Hz+dc) - 4*V*TANB1(1+TAN0D^2) / $m1(Hz^2-dc^2)]/A = 0.8659 EQU.3-28

C2=[TAN0d(1-TAN0dTANB1)-TANB1 + 2*Cd(1-TAN0dTANB1) / $m1(Hz+dc) +
+ 2V*TANB1^2(1+TAN0D^2) / $m1(Hz^2-dc^2)]/A= 1.0000 EQU.3-29

CRIT. ALPHA (a1)= ARCTAN((C1+(C1^2*4C2)^.5)/2 = 56.705 (DRIVING)

DETERMINE $avg FOR DRIVING WEDGE WITHOUT SURCHARGE

$avg = [$m1*Hz^2 / 2*(TANa1-TANB1) - ($m1-$b1)*h1^2 / 2*TANa1] / Hz^2 / 2*(TANa1-TANB1) = 0.114 kcf

SLIP-PLANE ANGLE WITHOUT SURCHARGE WITH AVERAGE SOIL UNIT WEIGHT

A= TAN0d + 2*Cd(1-TAN0dTANB1) / $avg(Hz+dc) - 2*V(1+TAN0d^2) / $avg(Hz^2-dc^2) = 0.4329 EQU. 3-30

C1=[2*TAN0d^2 + 4*Cd(TAN0d+TANB1) / $avg(Hz+dc) - 4*V*TANB1(1+TAN0D^2) / $avg(Hz^2-dc^2)]/A = 0.8659 EQU.3-28

C2=[TAN0d(1-TAN0dTANB1)-TANB1 + 2*Cd(1-TAN0dTANB1) / $avg(Hz+dc) +
+ 2V*TANB1^2(1+TAN0D^2) / $avg(Hz^2-dc^2)]/A= 1.0000 EQU.3-29

CRIT. ALPHA (a1)= ARCTAN((C1+(C1^2*4C2)^.5)/2 = 56.705 (DRIVING)

CHECK IF SURCHARGE EFFECTS DRIVING WEDGE

O/S DIST. TO SURCHARGE = 12.46 Ft.
WEDGE LENGTH W/O SURCHARGE= 14.91 Ft.

===> SURCHARGE LIES WITH IN WEDGE

SLIP-PLANE ANGLE WITH SURCHARGE

A= TAN0d+ 2*Cd(1-TAN0dTANB1) / $m1(Hz+dc) - 2*V(1+TAN0d^2) / $m1(Hz^2-dc^2) = 0.4329 EQU. 3-30

C1=[2*TAN0d^2+ + 4*Cd(TAN0d+TANB1) / $m1(Hz+dc) - 4*V*TANB1(1+TAN0D^2) / $m1(Hz^2-dc^2)]/A = 0.8659 EQU.3-28

C2=[TAN0d(1-TAN0dTANB1)-TANB1 + 2*Cd(1-TAN0dTANB1) / $m1(Hz+dc) +
+ 2V*TANB1^2(1+TAN0D^2) / $m1(Hz^2-dc^2)]/A= 1.0000 EQU.3-29

CRIT. ALPHA (a1)= ARCTAN((C1+(C1^2*4C2)^.5)/2 = 56.705 (DRIVING)

US ARMY CORPS OF ENGINEERS SAINT PAUL DISTRICT	PROJECT TITLE: CHASKA STAGE 3	COMPUTED BY: JHM	DATE: 07/15/93	SHEET: 16	51
	SUBJECT TITLE: DROP STRUCT. 1, DS WING WALLS	CHECKED BY: ct	DATE: 8/26/93	CONTRACT NO.:	

UP STREAM WING WALL, MONOLITH NO. 4, LOAD CASE – R1

RETAINING WALL DESIGN BASED ON ENGINEER MANUAL EM 1110-2-2502
KDH Version 3

RESISTING WEDGE PROPERTIES

03d = 23.41 DEG.

A= TAN03d + 2*Cr(1+TAN03dTANB3) / §m3*V5 + 2*V(1+TAN03d^2) / §m3(V5^2) = 0.4329 EQU. 3-38

C1=[2*TAN03d^2 + 4*Cr(TAN03d-TANB3) / §m3*V5 - 4*V*TANB3(1+TAN03d^2) / §m3*(V5^2)]/A = 0.8659 EQU.3-36

C2=[TAN03d(1+TAN03dTANB3) + TANB3 + 2*Cr(1+TAN03dTANB3) / §m3*V5 - 2V*TANB3^2(1+TAN03d^2) / §m3*(V5^2)]/A= 1.0000 EQU.3-37

CRIT. ALPHA (a3)= ARCTAN((-C1+(C1^2*4C2)^.5)/2 = 33.295 (RESIST.)

DETERMINE §avg FOR RESISTING WEDGE

§avg = [§m3*V5^2 / 2*(TANa3-TANB3) - (§m3-§b3)*h2^2 / 2*TANa3] / V5^2 / 2*(TANa3-TANB3) = 0.1140

A= TAN0 + 2*Cr(1+TAN03TANB3) / §avg*V5 + 2*V(1+TAN03^2) / §avg(V5^2) = 0.4329 EQU. 3-38

C1=[2*TAN03^2 + 4*Cr(TAN03-TANB3) / §avg*V5 - 4*V*TANB3(1+TAN03^2) / §avg*(V5^2)]/A = 0.8659 EQU.3-36

C2=[TAN03(1+TAN03TANB3) + TANB3 + 2*Cr(1+TAN03TANB3) / §avg*V5 - + 2V*TANB3^2(1+TAN03^2) / §avg*(V5^2)]/A= 1.0000 EQU.3-37

CRIT. ALPHA (a3)= ARCTAN((-C1+(C1^2*4C2)^.5)/2 = 33.295 (RESIST.)

RESISTING SIDE PRESSURE COEFFICIENTS (APPENDIX H p. H-9)

BASIC COEF. K = (1+TAN03*COTa3)/(1-TAN03*TANa3) = 2.3184
AT REST K = (1-SIN(03)) = 0.46

FILL MOIST K1= K*(TANa3/(TANa3-TANB3))= K * 1.0000
K1= 2.3184

FILL BOUYANT Kb= K[1+{TANa3/(TANa3-TANB3)-1}(§m3/§b3)] =
Kb= 2.3184

LENGTH OF COHESION = (V5)/(COSa3*(TANa3-TANB3)) = 16.03

		PASSIVE	AT REST
EQUIV. PRESSURE =	§m3*K1 =	0.2643	0.0519
	§b3*Kb =	0.1497	0.0294

US ARMY CORPS OF ENGINEERS SAINT PAUL DISTRICT	PROJECT TITLE: CHASKA STAGE 3	COMPUTED BY: JHM	DATE: 07/13/93	SHEET: 18	51
	SUBJECT TITLE: DROP STRUCT. 1, DS WING WALLS	CHECKED BY: xt	DATE: 8/26/93	CONTRACT NO.:	

UP STREAM WING WALL, MONOLITH NO. 4, LOAD CASE – R1

RETAINING WALL DESIGN BASED ON ENGINEER MANUAL EM 1110-2-2502
KDH Version 3

SUMMATION OF MOMENTS ABOUT THE TOE

AREA	VERT.	HORIZ.	WIDTH (FT)	UNIT WT. (K/CU.FT)	P VERT. (K/FT)	D (ARM)	M (FT-kips)
1	19.950	1.250	1.000	0.150	3.741	3.125	11.69
2	19.950	0.625	1.000	0.150	1.870	4.167	7.79
3	2.750	5.000	1.000	0.150	2.063	2.500	5.16
4	2.125	8.500	1.000	0.150	2.709	8.833	23.93
5	6.050	2.500	1.000	0.114	1.724	1.250	2.16
5A	0.000	2.500	1.000	0.127	0.000	1.250	0.00
5B	0.000	2.500	1.000	0.135	0.000	1.250	0.00
5C	0.000	2.500	1.000	0.063	0.000	1.250	0.00
6	0.000	1.250	1.000	0.114	0.000	4.375	0.00
6A	0.000	1.250	1.000	0.127	0.000	4.375	0.00
7	19.950	0.625	1.000	0.114	1.421	4.583	6.51
7A	0.000	0.000	1.000	0.127	0.000	5.000	0.00
8	19.950	8.500	1.000	0.114	19.332	9.250	178.82
8A	0.000	0.000	1.000	0.127	0.000	9.250	0.00
9	1.250	4.250	1.000	0.114	0.606	10.667	6.46
10	0.000	4.875	1.000	0.114	0.000	10.250	0.00
PARAPET	0.000	0.000	1.000	0.150	0.000	3.125	0.00

	P HOR.	P VERT.	D	M
DEAD LOAD TOTAL		33.466	7.247	242.52
HORIZONTAL WEDGE LOADS:				
L.E.P. SOIL (DRIVING)	-12.669		7.57	-95.86
VERTICAL COMPONENT		0.00	0.00	0.00
LATERAL WATER (DRIVING)	-0.00		0.00	-0.00
SURCHARGE (DRIVING)	0.00		0.00	0.00
L.E.P. SOIL + SURCHARGE (RESISTING)	2.01		2.93	5.90
VERTICAL COMPONENT (NOT COMPUTED)		0.00	0.00	0.00
LATERAL WATER (RESISTING)	0.000		0.00	0.00
UPLIFT		-0.00	6.75	-0.01
SUBTOTAL =====>	-10.66	33.46	4.56	152.5
ADDITIONAL LOADS:				
HIGHWAY L.L. SURCHARGE – FM BACKFILL	0.00		11.35	0.00
– VERT. ON STRUCTURAL WEDGE		0.00	8.625	0.00
SURCHARGE (STRUCTURAL WEDGE – Vs)		0.00	8.63	0.00
TOTAL =====>	**-10.66**	**33.46**	**4.56**	**152.55**

TOTAL WEIGHT OF STRUCTURAL WEDGE = 33.46 kips

OVERTURNING STABILITY ANALYSIS

Xr= SUM MOMENT ABOUT TOE/SUM OF VERTICAL FORCES
SUM MOM= 152.5 F-kips
Pvert = 33.46 kips $\bar{X}$ = 4.56 FT.

ECCENTRICITY e= HT/2-$\bar{X}$ = 2.19 < 2.25 = HT/6

% BASE IN COMP.= 3*$\bar{X}$/HT =* 100.0 %

CRITERIA SATISFIED

US ARMY CORPS OF ENGINEERS SAINT PAUL DISTRICT	PROJECT TITLE: CHASKA STAGE 3	COMPUTED BY: JHM	DATE: 07/13/93	SHEET: 20	51
	SUBJECT TITLE: DROP STRUCT. 1, DS WING WALLS	CHECKED BY: nt	DATE: 8/26/93	CONTRACT NO.:	

UP STREAM WING WALL, MONOLITH NO. 4, LOAD CASE – R1

RETAINING WALL DESIGN - BASED ON ENGINEER MANUAL EM 1110-2-2502
KDH Version 3

BASE PRESSURES DISTRIBUTION (FOOTING)

p1= P/HT*(1+6*e/HT) = IF e IS IN MIDDLE 1/3 OF FOOTING
p1 =2*P/{3*(HT/2−e)} = IF e IS OUTSIDE MIDDLE 1/3 OF FOOTING

p2= P/HT*(1−6*e/HT) = IF e IS IN MIDDLE 1/3 OF FOOTING
p2 = 0 IF e IS OUTSIDE MIDDLE 1/3 OF FOOTING

DISTANCE TO p2 = 13.50 FT

p1 = 4.8933 KSF p2 = 0.0644 KSF

STEM DESIGN (ULTIMATE STRENGTH)

CONC. STRENGTH (KSI) f'c=	4.00	REINF.STR.(KSI)fy=	60.00
COVER TO C.G. REINF.(IN)	4.50	LOAD FACTOR	2.21
WALL INCREMENT (FT)	1.00	STR. REDUCT FACTOR	0.90
As max based on p max =	2.18 in^2	MAX CRACK MOMENT	71.15

DISTANCE ABOVE FT TOP (FT)	WALL THICK. (IN)	d (IN)	ULT. MOMENT (F-K)	REQUIRED As (IN^2)	As min. 200/fy (IN^2)	.0014bD T & S As (IN^2)	DESIGN As (IN^2)	CHECK p <=p max p max = 0.00713
0.00	30.00	25.50	139.57	1.26	1.02	~~0.32~~ .50	1.26	0.00413
1.00	29.25	24.75	120.79	1.12	0.99	~~0.32~~	1.12	0.00378
2.00	28.50	24.00	103.48	0.99	0.96	~~0.31~~	0.99	0.00343
3.00	27.74	23.24	87.66	0.86	0.93	~~0.30~~	0.93	0.00333
4.00	26.99	22.49	73.33	0.74	0.90	~~0.29~~	0.90	0.00333
5.00	26.24	21.74	60.50	0.63	0.87	~~0.28~~	0.84	0.00323
6.00	25.49	20.99	49.17	0.53	0.84	~~0.28~~	0.71	0.00281
7.00	24.74	20.24	39.33	0.44	0.81	~~0.27~~	0.59	0.00241
8.00	23.98	19.48	30.91	0.36	0.78	~~0.26~~ .40	~~0.48~~ .50	0.00204
9.00	23.23	18.73	23.78	0.29	0.75	~~0.25~~ .39	~~0.38~~	0.00169
10.00	22.48	17.98	17.84	0.22	0.72	~~0.24~~	~~0.30~~	0.00137
11.00	21.73	17.23	12.98	0.17	0.69	~~0.23~~	~~0.23~~	0.00109
12.00	20.98	16.48	9.10	0.12	0.66	~~0.23~~	~~0.23~~	0.00083
13.00	20.23	15.73	6.08	0.09	0.63	~~0.22~~	~~0.22~~	0.00061
14.00	19.47	14.97	3.82	0.06	0.60	~~0.21~~	~~0.21~~	0.00042
15.00	18.72	14.22	2.20	0.03	0.57	~~0.20~~	~~0.20~~	0.00027
16.00	17.97	13.47	1.12	0.02	0.54	~~0.19~~	~~0.19~~	0.00015
17.00	17.22	12.72	0.46	0.01	0.51	~~0.19~~	~~0.19~~	0.00007
18.00	16.47	11.97	0.13	0.00	0.48	~~0.18~~	~~0.18~~	0.00002
19.00	15.71	11.21	0.02	0.00	0.45	~~0.17~~	~~0.17~~	0.00000
20.00	15.00	10.50	0.00	0.00	0.42	~~0.16~~	~~0.16~~	0.00000
21.00	15.00	10.50	0.00	0.00	0.42	~~0.16~~	~~0.16~~	0.00000
22.00	15.00	10.50	0.00	0.00	0.42	~~0.16~~	~~0.16~~	0.00000

CHECK SHEAR (STEM)

STR. RED FACTOR 0= 0.85 Vc = 2*(f'c)^.5*b*d ACI EQU.(11−3)
ULT.SHEAR < 2/3*0*Vc ACI 12.10.5.1
AT CUT OF POINT

DISTANCE ABOVE FT BOTTOM (FT)	WALL THICK. (IN)	D (IN)	ULT. SHEAR (kip)	Vc SHEAR (kip)	0*Vc SHEAR (kip)
0.00	30.00	25.50	19.53	38.71	32.90

US ARMY CORPS OF ENGINEERS SAINT PAUL DISTRICT	PROJECT TITLE: CHASKA STAGE 3	COMPUTED BY: JHM	DATE: 07/13/93	SHEET: 22	51
	SUBJECT TITLE: DROP STRUCT. 1, US WING WALLS	CHECKED BY: 丈	DATE: 8/26/93	CONTRACT NO.:	

UP STREAM WING WALL, MONOLITH NO. 4, LOAD CASE – R1

RETAINING WALL DESIGN BASED ON ENGINEER MANUAL EM 1110-2-2502
KDH Version 3

CHECK SHEAR (TOE)

STR. RED FACTOR 0= 0.85 Vc = 2*(f'c)^.5*b*d ACI EQU.(11-3)
ULT.SHEAR < 0*Vc ACI 12.10.5.1

DISTANCE FROM TOE (FT)	WALL THICK. (IN)	d (IN)	ULT. SHEAR (kip)	Vc SHEAR (kip)	0*Vc SHEAR (kip)
2.50	33.00	28.50	22.29	43.26	36.77 ✓

QUANTITIES

CONCRETE	
STEM	1.39 CU.YD.
PARAPET	0.00 CU.YD.
FOOTING	1.18 CU.YD.
TOTAL	2.56 CU.YD.

US ARMY CORPS OF ENGINEERS SAINT PAUL DISTRICT	PROJECT TITLE: CHASKA STAGE 3	COMPUTED BY: JHM	DATE: 07/12/93	SHEET: 24	51
	SUBJECT TITLE: DROP STRUCT. 1, DS WING WALLS	CHECKED BY: rt	DATE: 8/26/93	CONTRACT NO.:	

UP STREAM WING WALL, MONOLITH NO. 4, LOAD CASE – R2

RETAINING WALL DESIGN BASED ON ENGINEER MANUAL EM 1110-2-2502
KDH Version 3

WALL SECTION PROPERTIES

TOTAL HEIGHT,VT (FT.)	22.700	HEEL DEPTH @ BACK,V8 (FT)	1.500
FOOTING DEPTH TOE,V1 (FT.)	2.75 ~~2.500~~	STEM BATTER	0.0619
STEM HEIGHT,V2 (FT.)	20.200	WALL WIDTH AT TOP,H1 (FT.)	1.250
STRAIGHT WALL HT.,V3 (FT.)	0.000	WALL WIDTH AT BOT.,H2 (FT.)	2.500
SLOPED WALL HT., V4 (FT.)	20.200	WALL SLOPE,H3 (FT.)	1.250
B.O.F. TO T.O.S., V5 (FT.)	8.800	FOOTING TOE WIDTH,H4 (FT.)	2.500
SOIL DEPTH, V6 (FT.)	6.300	FOOTING HEEL WIDTH,H5 (FT.)	8.500
FOOTING DEPTH HEEL, V7(FT)	2.500	FOOTING WIDTH,HT (FT.)	13.500
		UNIT WEIGHT CONC.,(K/CUFT)	0.150
DEPTH OF RIPRAP IN CHANNEL	1.800	UNIT WEIGHT RIPRAP,(K/CUFT)	0.135

ADDITIONAL VERTICAL LOADS

LOADS ON BACKFILL		LOADS ON STRUCTURAL WEDGE ***	
HIGHWAY L.L. SURCHARGE	0.000 K/FT	HIGHWAY L.L. SURCHARGE	0.000 K/FT
LIVE LOAD SURCHARGE (vd)*	0.000 K/FT	LIVE LOAD SURCHARGE	0.000 K/FT
Vd =	0.000 K	SURCHARGE (Vs)**	0.000 K
SURCHARGE LOCATION S =	12.034 FT	DIST. TO F. WALL FACE	6.125 FT
(DRIVING WEDGE) X =	0.000 FT	SURCHARGE LOCATION X1=	1.250 FT
LOADS ON RESISTING WEDGE		FROM F. FACE OF WALL X2=	11.000 FT
RIPRAP (vr)**	0.131 K/FT		
		PARAPET LOAD	
		– HEIGHT	0.000 FT
		– WIDTH	0.000 FT

* A CHECK IS MADE TO DETERMINE IF THE SURCHARGE ON THE BACKFILL WILL LIE WITHIN THE INFLUENCE OF THE DRIVING WEDGE.

** IT IS CONSERVATIVE TO NEGLECT SURCHARGES Vr AND Vs. IF INCLUDED ASSURE THEY WILL STAY IN PLACE FOR THE CONDITION ANALYZED.

*** THESE LOADS ARE ASSUMED TO ACT ON THE BACKFILL SIDE OF WALL ONLY.

STABILITY REQUIREMENTS

LOADING CONDITIONS CASE ======>	R2		
% OF PASSIVE PRESSURE USED	50	SLIDING SAFETY FACTOR	1.33
MIN. BASE AREA IN COMPRESS.	75	BEARING CAP. SAFETY FACTOR	2.00

SOIL PROPERTIES (DRIVING WEDGE)

FRICTION ANGLE OF SOIL (01)	33.000 DEG.(DRIVING WEDGE)	
FRICTION ANGLE OF SOIL (02)	33.000 DEG.(STRUCT. WEDGE)	
SLOPE OF BACKFILL RISE/RUN	0.000	
BETA ANGLE (B1)	0.000 DEG.	
POINT AT WHICH BACKFILL SLOPE BEGINS		2.00 1=SLOPE BEGINS @ STEM
SOIL DEPTH BACK of HEEL(Hz)	22.700	2=SLOPE BEGINS@BACK OF HEEL
STR. MOBILIZATION FACTOR	0.750 (SMF)	
SOIL UNIT Wt.,MOIST (§m1)	0.1140 K/CUFT	
SOIL UNIT Wt.,SATUR. (§s1)	0.1270 K/CUFT	{ENTER §m1 IF NOT SATUR.}
SOIL UNIT Wt.,BOUYANT (§b1)	0.0699 K/CUFT	
DEPTH OF CRACK (dc)	0.000 FT.	
COHESION ON SLIP PLANE C=	0.000 KSF	
COHESION ON SLIP PLANE Cd=	0.000 KSF(DEVELOPED) =	Cd = (SMF)*C

US ARMY CORPS OF ENGINEERS SAINT PAUL DISTRICT	PROJECT TITLE: CHASKA STAGE 3	COMPUTED BY: JHM	DATE: 07/12/93	SHEET: 26	51
	SUBJECT TITLE: DROP STRUCT. 1, DS WING WALLS	CHECKED BY: tt	DATE: 8/26/93	CONTRACT NO.:	

UP STREAM WING WALL, MONOLITH NO. 4, LOAD CASE – R2

RETAINING WALL DESIGN BASED ON ENGINEER MANUAL EM 1110-2-2502
KDH Version 3

UPLIFT FORCES
(BY LINE OF CREEP METHOD – FIG. 3-32)

L-a'b = SAT. HEIGHT BACKFILL = 12.50 FT.
L-bc = FOOTING WIDTH,HT (FT.) = 13.50 FT.
L-cd' = SAT. HEIGHT, h2 (FT.) = 8.80 FT.

LENGTH OF SEEPAGE PATH (Ls) = L(a'b) + L(bc) + L(cd') = 34.80 FT.

:: hz – MEASURED TO ELEVATION OF POINT
WHERE UPLIFT IS CALCULATED

Ua =(hz-<h(L-a/Ls))§w=	0.00	Uc =(hz-<h(L-ac/Ls))§w=	0.6412
Ub =(hz-<h(L-ab/Ls))§w=	0.7139	Ud = hw*§w =	0.0437

U(DW) = (Ua+Ub/2)*L(a'b) =	4.462 K/FT.	Y (FT) =	4.17 FROM BASE
U(SW) = (Ub+Uc/2)*L(bc) =	9.147 K/FT.	X (FT) =	6.87 FROM TOE
U(RW1) = (Uc+Ud/2)*L(cd') =	3.014 K/FT.	Y (FT) =	3.12 FROM BASE
U(RW2) = Ud/2*(h2-L(cd')) =	0.015 K/FT.	Y (FT) =	9.03 FROM BASE
U(RWT) = U(RW1)+U(RW2) =	3.029 K/FT	Y (FT) =	3.15 FROM BASE

LATERAL FORCE COEFFICIENTS, FROM CALCULATIONS

Driving Side Moist Coefficient	0.39
Driving Side Saturated Coefficient	0.39
Resisting Side At Rest Coefficient	0.46
Resisting Side Moist Passive Coeffficient	2.56
Resisting Side Saturated Passive Coeffficient	2.56

LATERAL FORCES USING COEFFICIENTS

DRIVING SIDE FORCES

	Moist Triangle	Moist Rectangle	Saturated Triangle	Total	Live Load
Force	2.32	5.68	2.13	10.14 K	0.00
Ybar	15.90	6.25	4.17	8.02	16.28
Moment	36.86	35.51	8.89	81.27	0.00

Pw = 4.462 K

RESISTING SIDE EARTH PRESSURE WITH SURCHARGE

RESISTING SIDE, FULL PASSIVE (WITH PHId)

	Moist Triangle	Moist Rectangle	Saturated Triangle	Riprap Load	Total
Force	0.00	0.00	5.85	0.33	6.19
Ybar	9.27	4.75	2.93	4.40	3.01
Moment	0.00	0.00	17.17	1.47	18.64

RESISTING SIDE, AT REST

	Moist Triangle	Moist Rectangle	Saturated Triangle	Riprap Load	Total
Force	0.00	0.00	1.04	0.52	1.57
Ybar	9.27	4.75	2.93	4.40	3.42
Moment	0.00	0.00	3.06	2.30	5.36

Pw = 3.014 K

US ARMY CORPS OF ENGINEERS SAINT PAUL DISTRICT	PROJECT TITLE: CHASKA STAGE 3	COMPUTED BY: JHM	DATE: 07/12/93	SHEET: 28	51
	SUBJECT TITLE: DROP STRUCT. 1, DS WING WALLS	CHECKED BY: st	DATE: 8/26/93	CONTRACT NO.:	

UP STREAM WING WALL, MONOLITH NO. 4, LOAD CASE – R2

RETAINING WALL DESIGN BASED ON ENGINEER MANUAL EM 1110-2-2502
KDH Version 3

SLIDING STABILITY ANALYSIS

N' = Vsum = 26.27 kips T = Hsum = 10.00 kips (AT REST)
0 = 30.00 L = % BASE IN COMPRESSION * HT = 12.15
C = 0.00 FS = 1.33

FS = N'*TAN0 + CL / SUM Fh = 1.52 USING AT REST PRESSURE

-> SLIDING CRITERIA IS SATISFIED

FORCES FOR OVERTURNING ANALYSIS

N'*TAN(0) (no cohesion) = 15.16 kips
RESISTING FORCE NEEDED = 0.00 kips

MAX ALLOW RESIST FORCE (.5Kp) = 3.09 kips

CHECK BEARING CAPACITY

BEARING CAPACITY = Q EQU. 5-2
Q= B[(EcdEciEctEcgCNc)+(EqdEqiEqtEqgqoNq)+(ErdEriErtErgB($m-f)Nr)/2]

ECCEN. OF LOAD e= 2.70

EFFECTIVE WIDTH OF BASE B= HT-2e = 8.10

BEARING CAPACITY FACTORS FROM TABLE 5-1 EM 1110-2-2502
Nq = 18.40
Nc = 30.14
Nr = 15.67

EMBEDMENT FACTORS
Ecd = 1+0.2(V5/B)TAN(45+0/2) = 1.400 EQU.5-4a
Eqd=Erd = = 1.000 EQU.5-4b IF(0 = O)
Eqd=Erd = 1+0.1(V5/B)TAN(45+0/2) = EQU.5-4c IF(0 >10)
Eqd=Erd = = 1.200 FOR (O<0<=1O)
INTERPOLATE BETWEEN EQU. 5-4b AND 4c

INCLINATION FACTORS
$o = ARCTAN[(SUM H)/SUM V] = 20.85 DEG.
Eqi=Eci = (1-$o/90)^2 = 0.590 EQU.5-5a
Eri = IF $o > FRIC. ANGLE(0) THEN Eri = 0, ELSE,
Eri = (1-$o/0)^2 = 0.093 EQU.5-5b

BASE TILT FACTORS (A2 IN RADIANS)
Eqt=Ert = (1-a2*TAN0)^2 = 1.000 EQU.5-6a
Ect = 1-(2*a2/PI+2) EQU.5-6b (IF 0 =O)
Ect = Eqt-[(1-Eqt)/(NcTAN0)] EQU.5-6c (IF 0 >O)
Ect = 1.000

GROUND SLOPE FACTORS
Erg=Eqg = [1-TAN(-B3)]^2 = 1.000 EQU.5-7a
Ecg = 1-[2*(-B3)/(PI+2)] (B3 IN RAD.) EQU.5-7b (IF 0 =O)
Ecg = Eqg-[(1-Eqg)/Nc*TAN0] EQU.5-7d (IF 0 >O)
Ecg = 1.000

EFFECTIVE OVERBURDEN PRESSURE
qo = ($3*V5+RIPRAP)*COS/B3/ = 0.651 EQU.5-8a

BEARING CAPACITY = 68.71 kips EQU. 5-2
F.O.S. = Q/SUM V= 2.616 EQU. 5-1
BEARING CAPACITY IS SATISFIED

US ARMY CORPS OF ENGINEERS SAINT PAUL DISTRICT	PROJECT TITLE: CHASKA STAGE 3	COMPUTED BY: JHM	DATE: 07/12/93	SHEET: 30	51
	SUBJECT TITLE: DROP STRUCT. 1, DS WING WALLS	CHECKED BY: [illegible]	DATE: 8/26/93	CONTRACT NO.:	

UP STREAM WING WALL, MONOLITH NO. 4, LOAD CASE – R2

RETAINING WALL DESIGN BASED ON ENGINEER MANUAL EM 1110–2–2502
KDH Version 3

HEEL DESIGN (ULTIMATE STRENGTH)

CONC. STRENGTH (KSI)	4.00	REINF. STR.(KSI)	60.00
FOOTING INCREMENTS	1.00	LOAD FACTOR	2.21
COVER TO C.G. REINF.(IN)	4.50	STR. REDUCT FACTOR	0.90
As max based on p max =	2.18 in^2	MAX CRACK MOMENT	71.15

DISTANCE FROM HEEL BACK (FT)	HEEL THICK. (IN)	d (IN)	ULT MOMENT (F–K)	REQUIRED As (IN^2)	As min. 200/fy (IN^2)	T & S As (IN^2)	DESIGN As (IN^2)	CHECK p <=p max p max = 0.00713
8.500	30.00	25.50	119.25	1.07	1.02	0.32	1.07	0.00350
7.500	28.59	24.09	99.48	0.95	0.96	0.31	0.96	0.00333
6.500	27.18	22.68	79.59	0.80	0.91	0.29	0.91	0.00333
5.500	25.76	21.26	60.35	0.65	0.85	0.28	0.85	0.00333
4.500	24.35	19.85	42.51	0.48	0.79	0.26	0.65	0.00271
3.500	22.94	18.44	26.86	0.33	0.74	0.25	0.44	0.00198
2.500	21.53	17.03	14.15	0.19	0.68	0.23	0.25	0.00121
1.500	20.12	15.62	5.16	0.07	0.62	0.22	0.22	0.00052
0.500	18.71	14.21	0.57	0.01	0.57	0.20	0.20	0.00007
0.000	18.00	13.50	0.00	0.00	0.54	0.19	0.19	0.00000
0.000	18.00	13.50	0.00	0.00	0.54	0.19	0.19	0.00000
0.000	18.00	13.50	0.00	0.00	0.54	0.19	0.19	0.00000
0.000	18.00	13.50	0.00	0.00	0.54	0.19	0.19	0.00000

CHECK SHEAR (HEEL)

STR. RED FACTOR 0= 0.85   Vc = 2*(f'c)^.5*b*d   ACI EQU.(11–3)
ULT.SHEAR < 0*Vc   ACI 12.10.5.1

DISTANCE U BACK (FT)	WALL THICK. (IN)	d (IN)	ULT. SHEAR (kip)	Vc SHEAR (kip)	0*Vc SHEAR (kip)
8.50	30.00	25.50	19.45	38.71	32.90

TOE DESIGN (ULTIMATE STRENGTH)

CONC. STRENGTH (KSI)	4.00	REINF. STR.(KSI)	60.00
FOOTING INCREMENTS	0.50	LOAD FACTOR	2.21
COVER TO C.G. REINF.(IN)	4.50	STR. REDUCT FACTOR	0.90
As max based on p max =	2.18 in^2	MAX CRACK MOMENT	71.15

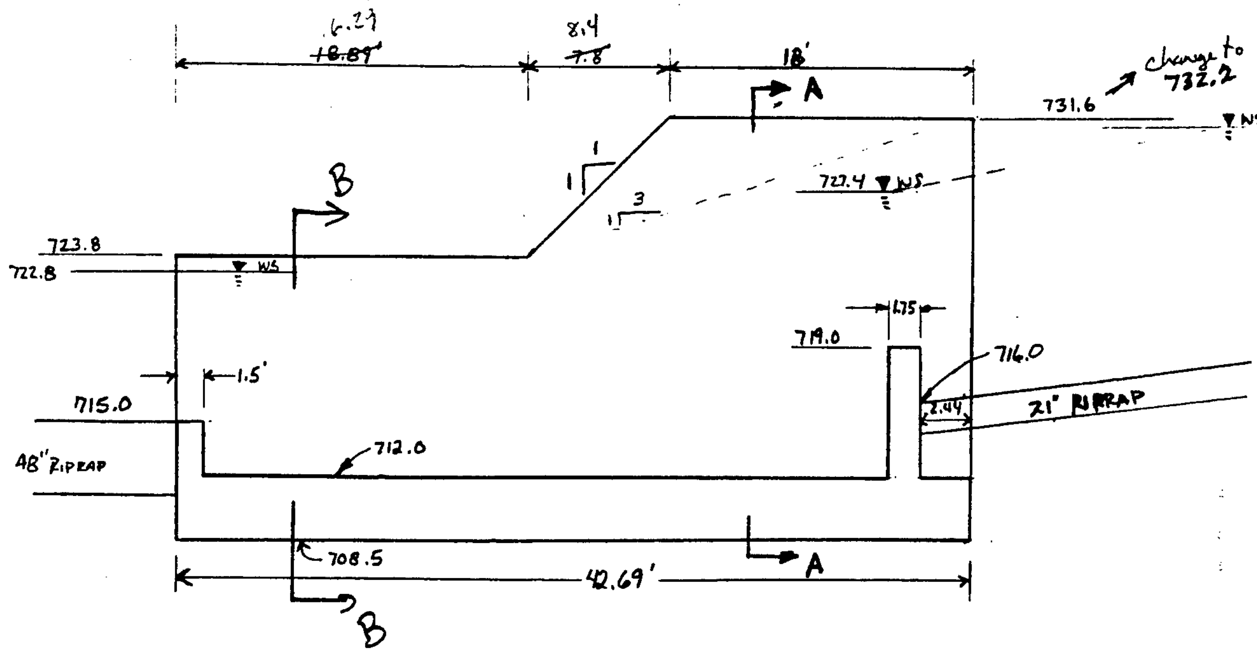
DISTANCE FROM TOE (FT)	TOE THICK. (IN)	d (IN)	ULT MOMENT (F–K)	REQUIRED As (IN^2)	As min. 200/fy (IN^2)	T & S As (IN^2)	DESIGN As (IN^2)	CHECK p <=p max
2.50	30.00	25.50	22.95	0.20	1.02	0.32	0.32	0.00088
2.00	30.00	25.50	14.95	0.13	1.02	0.32	0.32	0.00057
1.50	30.00	25.50	8.55	0.07	1.02	0.32	0.32	0.00033
1.00	30.00	25.50	3.87	0.03	1.02	0.32	0.32	0.00015
0.50	30.00	25.50	0.98	0.01	1.02	0.32	0.32	0.00004
0.00	30.00	25.50	0.00	0.00	1.02	0.32	0.32	0.00000
0.00	30.00	25.50	0.00	0.00	1.02	0.32	0.32	0.00000

SAMPLE COMPUTATIONS

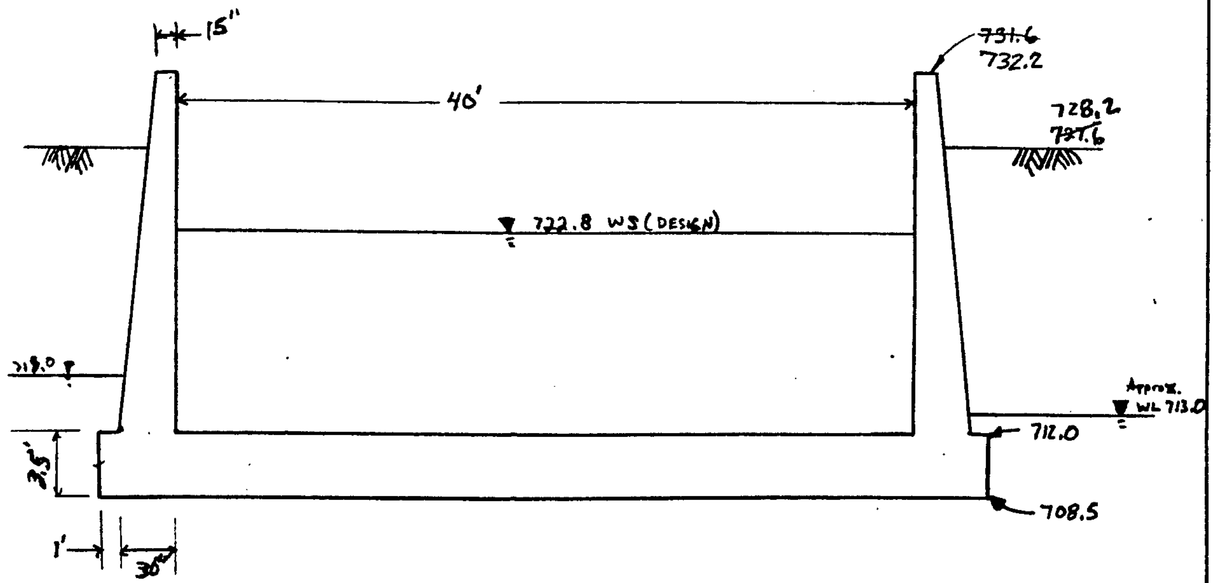
DROP STRUCTURE 1

US Army Corps of Engineers Saint Paul District	PROJECT TITLE: CHASKA – STAGE 3	COMPUTED BY: JHM	DATE: 7 JUN 93	SHEET: 1	40
	SUBJECT TITLE: DROP STRUCTURE 1	CHECKED BY:	DATE: [illegible]	CONTRACT NO.:	

(TRIAL 1)



USE SECTION AA
12' DS of US END.
for High Wall
use BB for Low Wall.



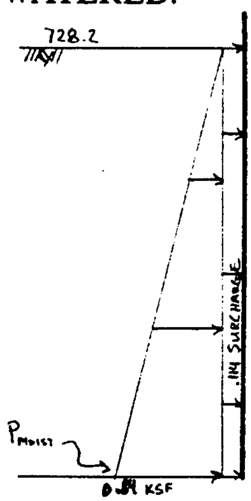
SECTION A-A

US Army Corps of Engineers Saint Paul District	PROJECT TITLE: CHASKA – STAGE 3	COMPUTED BY: JHM	DATE: 06/30/93	SHEET: 3	OF: 40
	SUBJECT TITLE: DROP STRUCTURE 1 – LOAD CASES	CHECKED BY:	DATE:	CONTRACT NO.:	

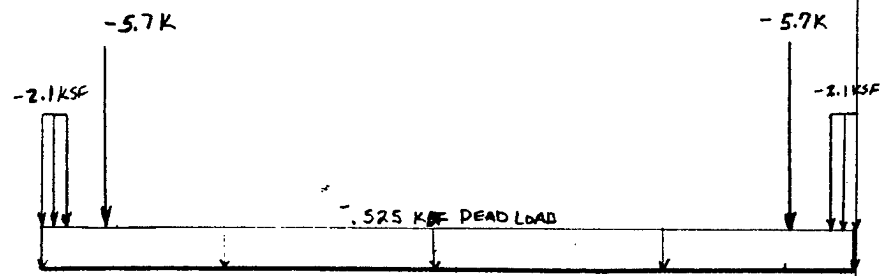
FOR SECTION A-A

DS1AWK1

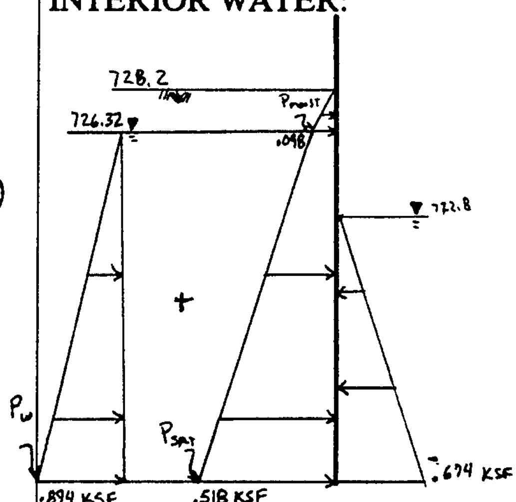
DEWATERED:



(DEAD LOAD, MOIST SOIL LOAD, SURCHARGE)

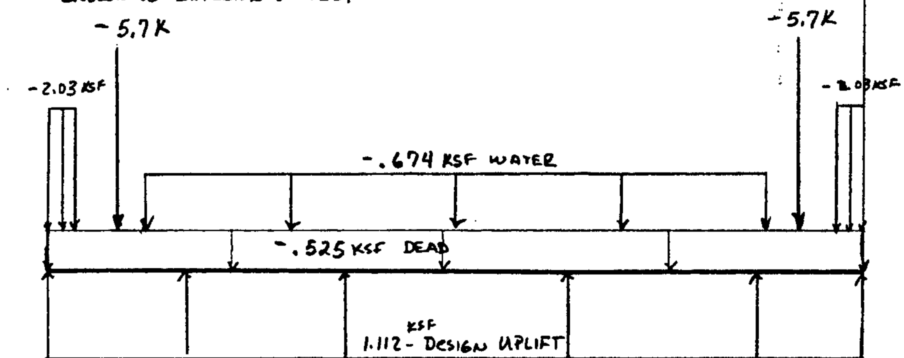


INTERIOR WATER:

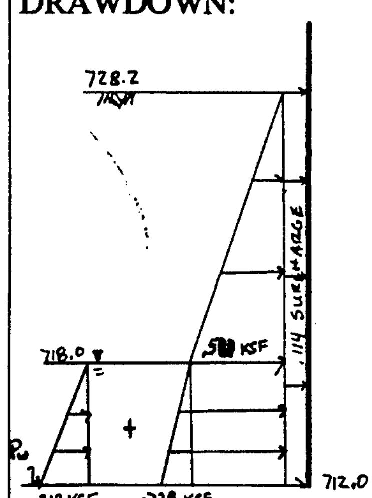


(DEAD LOAD, MOIST SOIL LOAD, INTERIOR WATER, DESIGN UPLIFT)

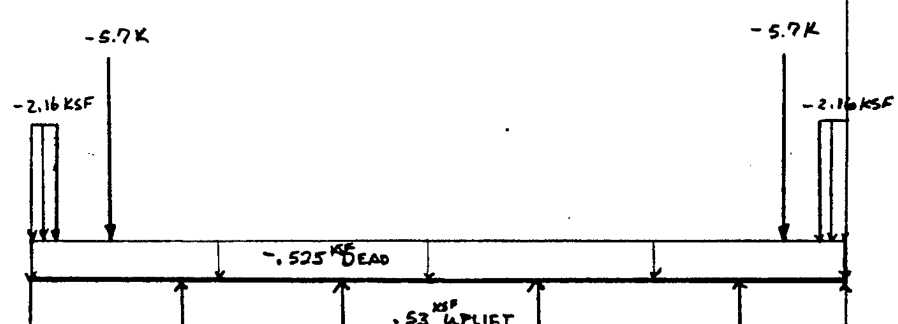
INCLUDING EXTERIOR WATER.



DRAWDOWN:



(DEAD LOAD, MOIST & SAT SOIL, SURCHARGE, EXTERIOR WATER)



CFRAME INPUT (CONTINUED)

0220 LOAD CASE 7 1 4 0 0 0 MOIST & SATURATED SOIL 2
0221 Y –2.03 1 16
0222 0 .518 14.32 .098 0 18
0223 14.32 .098 16.2 0 0 18
0224 0 –.518 14.32 –.098 0 20
0225 14.32 –.098 16.2 0 0 20
0230 LOAD CASE 8 0 2 0 0 0 EXTERIOR WATER 2
0231 0 .894 14.32 0 0 18
0232 0 –.894 14.32 0 0 20
0240 COMBINATION 9 1 1.0,2 1.0,3 1.0,DEWATERED
0241 COMBINATION 10 1 1.0,5 1.0,7 1.0,8 1.0,INTERIOR WATER
0242 COMBINATION 11 1 1.0,3 1.0,4 1.0,6 1.0,DRAWDOWN

END OF INPUT

DROP STRUCTURE 1 (SOIL MOD = 1 K/CF)

MEMBER	END A	END B	LENGTH FT	I IN**4	A IN**2	AS IN**2	E KSI	G KSI
13	13	14	4.00	.7409E+05	.5040E+03	.5040E+03	.3824E+04	.1634E+04
14	14	15	1.00	.7409E+05	.5040E+03	.5040E+03	.3824E+04	.1634E+04
15	15	16	1.50	.7409E+05	.5040E+03	.5040E+03	.3824E+04	.1634E+04
16	16	17	1.00	.7409E+05	.5040E+03	.5040E+03	.3824E+04	.1634E+04
17	3	18	1.75	.7500E+08	.5040E+03	.5040E+03	.3824E+04	.1634E+04
18	18	19	20.20	.1382E+05	.2880E+03	.2880E+03	.3824E+04	.1634E+04
19	15	20	1.75	.7500E+08	.5040E+03	.5040E+03	.3824E+04	.1634E+04
20	20	21	20.20	.1382E+05	.2880E+03	.2880E+03	.3824E+04	.1634E+04

*** LOAD CASE 1 DEAD LOADS

MEMBER	DIRECTION	PROJECTED LOAD KIP / FT
1	Y	-.5250E+00
2	Y	-.5250E+00
3	Y	-.5250E+00
4	Y	-.5250E+00
5	Y	-.5250E+00
6	Y	-.5250E+00
7	Y	-.5250E+00
8	Y	-.5250E+00
9	Y	-.5250E+00
10	Y	-.5250E+00
11	Y	-.5250E+00
12	Y	-.5250E+00
13	Y	-.5250E+00
14	Y	-.5250E+00
15	Y	-.5250E+00
16	Y	-.5250E+00

JOINT	FORCE X KIP	FORCE Y KIP	MOMENT FT-KIP
18	.0000E+00	-.5700E+01	.0000E+00
20	.0000E+00	-.5700E+01	.0000E+00

*** LOAD CASE 2 MOIST SOIL LOADS

MEMBER	DIRECTION	PROJECTED LOAD KIP / FT
1	Y	-.1850E+01
16	Y	-.1850E+01

MEMBER	LA FT	PA KIP / FT	LB FT	PB KIP / FT	ANGLE DEG
18	.00	.8400E+00	16.20	.0000E+00	.00
20	.00	-.8400E+00	16.20	.0000E+00	.00

DROP STRUCTURE 1 (SOIL MOD = 1 K/CF)

MEMBER	DIRECTION	PROJECTED LOAD KIP / FT
10	Y	.1112E+01
10	Y	-.6740E+00
11	Y	.1112E+01
11	Y	-.6740E+00
12	Y	.1112E+01
12	Y	-.6740E+00
13	Y	.1112E+01
13	Y	-.6740E+00
14	Y	.1112E+01
15	Y	.1112E+01
16	Y	.1112E+01

MEMBER	LA FT	PA KIP / FT	LB FT	PB KIP / FT	ANGLE DEG
18	.00	-.6740E+00	10.80	.0000E+00	.00
20	.00	.6740E+00	10.80	.0000E+00	.00

*** LOAD CASE 6 EXTERIOR WATER 1

MEMBER	DIRECTION	PROJECTED LOAD KIP / FT
1	Y	.5300E+00
1	Y	-.3120E+00
2	Y	.5300E+00
3	Y	.5300E+00
4	Y	.5300E+00
5	Y	.5300E+00
6	Y	.5300E+00
7	Y	.5300E+00
8	Y	.5300E+00
9	Y	.5300E+00
10	Y	.5300E+00
11	Y	.5300E+00
12	Y	.5300E+00
13	Y	.5300E+00
14	Y	.5300E+00
15	Y	.5300E+00
16	Y	.5300E+00
16	Y	-.3120E+00

MEMBER	LA FT	PA KIP / FT	LB FT	PB KIP / FT	ANGLE DEG
18	.00	.3120E+00	5.00	.0000E+00	.00
20	.00	-.3120E+00	5.00	.0000E+00	.00

DROP STRUCTURE 1 (SOIL MOD = 1 K/CF)

LOAD CASE 9 DEWATERED

11/40

JOINT DISPLACEMENTS

JOINT	DX IN	DY IN	DR RAD
1	.0000E+00	-.8481E+00	-.1670E-03
2	.0000E+00	-.8501E+00	-.1671E-03
3	.0000E+00	-.8531E+00	-.1686E-03
4	-.5386E-04	-.8548E+00	-.1380E-03
5	-.2693E-03	-.8586E+00	-.4541E-04
6	-.4848E-03	-.8592E+00	.0000E+00
7	-.7002E-03	-.8583E+00	.2057E-04
8	-.9157E-03	-.8573E+00	.1568E-04
9	-.1131E-02	-.8568E+00	.0000E+00
10	-.1347E-02	-.8573E+00	-.1568E-04
11	-.1562E-02	-.8583E+00	-.2057E-04
12	-.1777E-02	-.8592E+00	.0000E+00
13	-.1993E-02	-.8586E+00	.4541E-04
14	-.2208E-02	-.8548E+00	.1380E-03
15	-.2262E-02	-.8531E+00	.1686E-03
16	-.2262E-02	-.8501E+00	.1671E-03
17	-.2262E-02	-.8481E+00	.1670E-03
18	.3762E-02	-.8531E+00	-.1687E-03
19	.1709E+00	-.8531E+00	-.7941E-03
20	-.6025E-02	-.8531E+00	.1687E-03
21	-.1732E+00	-.8531E+00	.7941E-03

MEMBER END FORCES

MEMBER	JOINT	AXIAL KIP	SHEAR KIP	MOMENT IN-KIP	MOMENT EXTREMA IN-KIP	LOCATION IN
1	1	.0000E+00	.4240E+00	.0000E+00	.4110E+00	1.92
	2	.0000E+00	.2201E+01	-.1066E+02	-.1066E+02	12.00
2	2	.0000E+00	-.1138E+01	-.1066E+02	-.1066E+02	.00
	3	.0000E+00	.1926E+01	-.3824E+02	-.3824E+02	18.00
3	3	-.8651E+01	-.6560E+01	.7638E+03	.7638E+03	.00
	4	-.8651E+01	.7085E+01	.6820E+03	.6820E+03	12.00
4	4	-.8651E+01	-.4948E+01	.6820E+03	.6820E+03	.00
	5	-.8651E+01	$\boxed{.7048E+01}$	.3941E+03	.3941E+03	48.00
5	5	-.8651E+01	-.3613E+01	.3941E+03	.3941E+03	.00
	6	-.8651E+01	.5713E+01	.1703E+03	.1703E+03	48.00
6	6	-.8651E+01	-.2276E+01	.1703E+03	.1703E+03	.00
	7	-.8651E+01	.4376E+01	.1061E+02	.1061E+02	48.00
7	7	-.8651E+01	-.9428E+00	.1061E+02	.1061E+02	.00
	8	-.8651E+01	.3043E+01	-.8505E+02	-.8505E+02	48.00
8	8	-.8651E+01	.3863E+00	-.8505E+02	-.8334E+02	8.64
	9	-.8651E+01	.1714E+01	-.1169E+03	-.1169E+03	48.00
9	9	-.8651E+01	.1714E+01	-.1169E+03	-.8334E+02	39.36
	10	-.8651E+01	.3863E+00	-.8505E+02	-.1169E+03	.00
10	10	-.8651E+01	.3043E+01	-.8505E+02	.1061E+02	48.00
	11	-.8651E+01	-.9428E+00	.1061E+02	-.8505E+02	.00
11	11	-.8651E+01	.4376E+01	.1061E+02	.1703E+03	48.00
	12	-.8651E+01	-.2276E+01	.1703E+03	.1061E+02	.00

DROP STRUCTURE 1 (SOIL MOD = 1 K/CF)

LOAD CASE 10 INTERIOR WATER

JOINT DISPLACEMENTS

JOINT	DX IN	DY IN	DR RAD
1	.0000E+00	-.2989E+00	-.2190E-03
2	.0000E+00	-.3015E+00	-.2191E-03
3	.0000E+00	-.3055E+00	-.2198E-03
4	-.4523E-04	-.3079E+00	-.1934E-03
5	-.2261E-03	-.3147E+00	-.1093E-03
6	-.4071E-03	-.3184E+00	-.5538E-04
7	-.5880E-03	-.3201E+00	-.2425E-04
8	-.7689E-03	-.3207E+00	.0000E+00
9	-.9498E-03	-.3209E+00	.0000E+00
10	-.1131E-02	-.3207E+00	.0000E+00
11	-.1312E-02	-.3201E+00	.2425E-04
12	-.1493E-02	-.3184E+00	.5538E-04
13	-.1673E-02	-.3147E+00	.1093E-03
14	-.1854E-02	-.3079E+00	.1934E-03
15	-.1900E-02	-.3055E+00	.2198E-03
16	-.1900E-02	-.3015E+00	.2191E-03
17	-.1900E-02	-.2989E+00	.2190E-03
18	.4802E-02	-.3055E+00	-.2199E-03
19	.1605E+00	-.3055E+00	-.7202E-03
20	-.6702E-02	-.3055E+00	.2199E-03
21	-.1624E+00	-.3055E+00	.7202E-03

MEMBER END FORCES

MEMBER	JOINT	AXIAL KIP	SHEAR KIP	MOMENT IN-KIP	MOMENT EXTREMA IN-KIP	LOCATION IN
1	1	.0000E+00	.1494E+00	.0000E+00	.9276E-01	1.20
	2	.0000E+00	.1294E+01	-.6865E+01	-.6865E+01	12.00
2	2	.0000E+00	-.9167E+00	-.6865E+01	-.6865E+01	.00
	3	.0000E+00	.3616E-01	-.1544E+02	-.1544E+02	18.00
3	3	-.7264E+01	-.5354E+01	.6559E+03	.6559E+03	.00
	4	-.7264E+01	.4767E+01	.5951E+03	.5951E+03	12.00
4	4	-.7264E+01	-.3998E+01	.5951E+03	.5951E+03	.00
	5	-.7264E+01	.4346E+01	.3949E+03	.3949E+03	48.00
5	5	-.7264E+01	-.3087E+01	.3949E+03	.3949E+03	.00
	6	-.7264E+01	.3435E+01	.2384E+03	.2384E+03	48.00
6	6	-.7264E+01	-.2161E+01	.2384E+03	.2384E+03	.00
	7	-.7264E+01	.2509E+01	.1263E+03	.1263E+03	48.00
7	7	-.7264E+01	-.1229E+01	.1263E+03	.1263E+03	.00
	8	-.7264E+01	.1577E+01	.5897E+02	.5897E+02	48.00
8	8	-.7264E+01	-.2938E+00	.5897E+02	.5897E+02	.00
	9	-.7264E+01	.6418E+00	.3651E+02	.3651E+02	48.00
9	9	-.7264E+01	.6418E+00	.3651E+02	.5897E+02	48.00
	10	-.7264E+01	-.2938E+00	.5897E+02	.3651E+02	.00
10	10	-.7264E+01	.1577E+01	.5897E+02	.1263E+03	48.00
	11	-.7264E+01	-.1229E+01	.1263E+03	.5897E+02	.00
11	11	-.7264E+01	.2509E+01	.1263E+03	.2384E+03	48.00
	12	-.7264E+01	-.2161E+01	.2384E+03	.1263E+03	.00

DROP STRUCTURE 1 (SOIL MOD = 1 K/CF)

LOAD CASE 11 DRAWDOWN

JOINT DISPLACEMENTS

JOINT	DX IN	DY IN	DR RAD
1	.0000E+00	-.3202E+00	-.1726E-03
2	.0000E+00	-.3223E+00	-.1727E-03
3	.0000E+00	-.3254E+00	-.1743E-03
4	-.5699E-04	-.3272E+00	-.1429E-03
5	-.2849E-03	-.3312E+00	-.4878E-04
6	-.5129E-03	-.3319E+00	.0000E+00
7	-.7409E-03	-.3311E+00	.1925E-04
8	-.9688E-03	-.3301E+00	.1507E-04
9	-.1197E-02	-.3297E+00	.0000E+00
10	-.1425E-02	-.3301E+00	-.1507E-04
11	-.1653E-02	-.3311E+00	-.1925E-04
12	-.1881E-02	-.3319E+00	.0000E+00
13	-.2109E-02	-.3312E+00	.4878E-04
14	-.2337E-02	-.3272E+00	.1429E-03
15	-.2394E-02	-.3254E+00	.1743E-03
16	-.2394E-02	-.3223E+00	.1727E-03
17	-.2394E-02	-.3202E+00	.1726E-03
18	.3894E-02	-.3254E+00	-.1744E-03
19	.1731E+00	-.3254E+00	-.8028E-03
20	-.6288E-02	-.3254E+00	.1744E-03
21	-.1755E+00	-.3254E+00	.8028E-03

MEMBER END FORCES

MEMBER	JOINT	AXIAL KIP	SHEAR KIP	MOMENT IN-KIP	MOMENT EXTREMA IN-KIP	LOCATION IN
1	1	.0000E+00	.1601E+00	.0000E+00	.7088E-01	.96
	2	.0000E+00	.1997E+01	-.1102E+02	-.1102E+02	12.00
2	2	.0000E+00	-.1594E+01	-.1102E+02	-.1102E+02	.00
	3	.0000E+00	.1587E+01	-.3965E+02	-.3965E+02	18.00
3	3	-.9153E+01	-.6880E+01	.7832E+03	.7832E+03	.00
	4	-.9153E+01	.6875E+01	.7006E+03	.7006E+03	12.00
4	4	-.9153E+01	-.6057E+01	$\boxed{.7006E+03}$	.7006E+03	.00
	5	-.9153E+01	.6037E+01	.4104E+03	.4104E+03	48.00
5	5	-.9153E+01	-.4712E+01	.4104E+03	.4104E+03	.00
	6	-.9153E+01	.4692E+01	.1847E+03	.1847E+03	48.00
6	6	-.9153E+01	-.3364E+01	.1847E+03	.1847E+03	.00
	7	-.9153E+01	.3344E+01	.2367E+02	.2367E+02	48.00
7	7	-.9153E+01	-.2020E+01	.2367E+02	.2367E+02	.00
	8	-.9153E+01	.2000E+01	-.7280E+02	-.7280E+02	48.00
8	8	-.9153E+01	-.6794E+00	-.7280E+02	-.7280E+02	.00
	9	-.9153E+01	.6594E+00	-.1049E+03	-.1049E+03	48.00
9	9	-.9153E+01	.6594E+00	-.1049E+03	-.7280E+02	48.00
	10	-.9153E+01	-.6794E+00	-.7280E+02	-.1049E+03	.00
10	10	-.9153E+01	.2000E+01	-.7280E+02	.2367E+02	48.00
	11	-.9153E+01	-.2020E+01	.2367E+02	-.7280E+02	.00
11	11	-.9153E+01	.3344E+01	.2367E+02	.1847E+03	48.00
	12	-.9153E+01	-.3364E+01	.1847E+03	.2367E+02	.00

17 40

DROP STRUCTURE 1 (SOIL MOD = 1 K/CF)

MEMBER END FORCES

MEMBER	LOAD CASE	JOINT	AXIAL KIP	SHEAR KIP	MOMENT IN-KIP	MOMENT EXTREMA IN-KIP	LOCATION IN
1	9	1	.0000E+00	.4240E+00	.0000E+00	.4110E+00	1.92
		2	.0000E+00	.2201E+01	-.1066E+02	-.1066E+02	12.00
	10	1	.0000E+00	.1494E+00	.0000E+00	.9276E-01	1.20
		2	.0000E+00	.1294E+01	-.6865E+01	-.6865E+01	12.00
	11	1	.0000E+00	.1601E+00	.0000E+00	.7088E-01	.96
		2	.0000E+00	.1997E+01	-.1102E+02	-.1102E+02	12.00
2	9	2	.0000E+00	-.1138E+01	-.1066E+02	-.1066E+02	.00
		3	.0000E+00	.1926E+01	-.3824E+02	-.3824E+02	18.00
	10	2	.0000E+00	-.9167E+00	-.6865E+01	-.6865E+01	.00
		3	.0000E+00	.3616E-01	-.1544E+02	-.1544E+02	18.00
	11	2	.0000E+00	-.1594E+01	-.1102E+02	-.1102E+02	.00
		3	.0000E+00	.1587E+01	-.3965E+02	-.3965E+02	18.00
3	9	3	-.8651E+01	-.6560E+01	.7638E+03	.7638E+03	.00
		4	-.8651E+01	.7085E+01	.6820E+03	.6820E+03	12.00
	10	3	-.7264E+01	-.5354E+01	.6559E+03	.6559E+03	.00
		4	-.7264E+01	.4767E+01	.5951E+03	.5951E+03	12.00
	11	3	-.9153E+01	-.6880E+01	.7832E+03	.7832E+03	.00
		4	-.9153E+01	.6875E+01	.7006E+03	.7006E+03	12.00
4	9	4	-.8651E+01	-.4948E+01	.6820E+03	.6820E+03	.00
		5	-.8651E+01	$\boxed{.7048E+01}$	.3941E+03	.3941E+03	48.00
	10	4	-.7264E+01	-.3998E+01	.5951E+03	.5951E+03	.00
		5	-.7264E+01	.4346E+01	.3949E+03	.3949E+03	48.00
	11	4	-.9153E+01	-.6057E+01	$\boxed{.7006E+03}$	.7006E+03	.00
		5	-.9153E+01	.6037E+01	.4104E+03	.4104E+03	48.00
5	9	5	-.8651E+01	-.3613E+01	.3941E+03	.3941E+03	.00
		6	-.8651E+01	.5713E+01	.1703E+03	.1703E+03	48.00
	10	5	-.7264E+01	-.3087E+01	.3949E+03	.3949E+03	.00
		6	-.7264E+01	.3435E+01	.2384E+03	.2384E+03	48.00
	11	5	-.9153E+01	-.4712E+01	.4104E+03	.4104E+03	.00
		6	-.9153E+01	.4692E+01	.1847E+03	.1847E+03	48.00
6	9	6	-.8651E+01	-.2276E+01	.1703E+03	.1703E+03	.00
		7	-.8651E+01	.4376E+01	.1061E+02	.1061E+02	48.00
	10	6	-.7264E+01	-.2161E+01	.2384E+03	.2384E+03	.00
		7	-.7264E+01	.2509E+01	.1263E+03	.1263E+03	48.00
	11	6	-.9153E+01	-.3364E+01	.1847E+03	.1847E+03	.00
		7	-.9153E+01	.3344E+01	.2367E+02	.2367E+02	48.00
7	9	7	-.8651E+01	-.9428E+00	.1061E+02	.1061E+02	.00
		8	-.8651E+01	.3043E+01	-.8505E+02	-.8505E+02	48.00
	10	7	-.7264E+01	-.1229E+01	.1263E+03	.1263E+03	.00
		8	-.7264E+01	.1577E+01	.5897E+02	.5897E+02	48.00
	11	7	-.9153E+01	-.2020E+01	.2367E+02	.2367E+02	.00
		8	-.9153E+01	.2000E+01	-.7280E+02	-.7280E+02	48.00

DROP STRUCTURE 1 (SOIL MOD = 1 K/CF)

MEMBER END FORCES

MEMBER	LOAD CASE	JOINT	AXIAL KIP	SHEAR KIP	MOMENT IN-KIP	MOMENT EXTREMA IN-KIP	LOCATION IN
15	9	15	.0000E+00	.1926E+01	-.3824E+02	-.1066E+02	18.00
		16	.0000E+00	-.1138E+01	-.1066E+02	-.3824E+02	.00
	10	15	.0000E+00	.3616E-01	-.1544E+02	-.6865E+01	18.00
		16	.0000E+00	-.9167E+00	-.6865E+01	-.1544E+02	.00
	11	15	.0000E+00	.1587E+01	-.3965E+02	-.1102E+02	18.00
		16	.0000E+00	-.1594E+01	-.1102E+02	-.3965E+02	.00
16	9	16	.0000E+00	.2201E+01	-.1066E+02	.4109E+00	10.08
		17	.0000E+00	.4240E+00	.0000E+00	-.1066E+02	.00
	10	16	.0000E+00	.1294E+01	-.6865E+01	.9276E-01	10.80
		17	.0000E+00	.1494E+00	.0000E+00	-.6865E+01	.00
	11	16	.0000E+00	.1997E+01	-.1102E+02	.7088E-01	11.04
		17	.0000E+00	.1601E+00	.0000E+00	-.1102E+02	.00
17	9	3	-.5700E+01	.8651E+01	-.8021E+03	-.6204E+03	21.00
		18	-.5700E+01	-.8651E+01	-.6204E+03	-.8021E+03	.00
	10	3	-.5700E+01	.7264E+01	-.6713E+03	-.5188E+03	21.00
		18	-.5700E+01	-.7264E+01	-.5188E+03	-.6713E+03	.00
	11	3	-.5700E+01	.9153E+01	-.8228E+03	-.6306E+03	21.00
		18	-.5700E+01	-.9153E+01	-.6306E+03	-.8228E+03	.00
18	9	18	.0000E+00	.8651E+01	-.6204E+03	.4917E-03	223.01
		19	.0000E+00	.0000E+00	.0000E+00	-.6204E+03	.00
	10	18	.0000E+00	.7264E+01	-.5188E+03	.7876E-03	218.16
		19	.0000E+00	.0000E+00	.0000E+00	-.5188E+03	.00
	11	18	.0000E+00	.9153E+01	-.6306E+03	.5677E-03	223.01
		19	.0000E+00	.0000E+00	.0000E+00	-.6306E+03	.00
19	9	15	-.5700E+01	-.8651E+01	.8021E+03	.8021E+03	.00
		20	-.5700E+01	.8651E+01	.6204E+03	.6204E+03	21.00
	10	15	-.5700E+01	-.7264E+01	.6713E+03	.6713E+03	.00
		20	-.5700E+01	.7264E+01	.5188E+03	.5188E+03	21.00
	11	15	-.5700E+01	-.9153E+01	.8228E+03	.8228E+03	.00
		20	-.5700E+01	.9153E+01	.6306E+03	.6306E+03	21.00
20	9	20	.0000E+00	-.8651E+01	.6204E+03	.6204E+03	.00
		21	.0000E+00	.0000E+00	.0000E+00	-.4917E-03	223.01
	10	20	.0000E+00	-.7264E+01	.5188E+03	.5188E+03	.00
		21	.0000E+00	.0000E+00	.0000E+00	-.7876E-03	218.16
	11	20	.0000E+00	-.9153E+01	.6306E+03	.6306E+03	.00
		21	.0000E+00	.0000E+00	.0000E+00	-.5677E-03	223.01

US Army Corps of Engineers Saint Paul District	PROJECT TITLE: CHASKA – STAGE 3	COMPUTED BY: JHM	DATE: 06/30/93	SHEET: 21	OF: 40
	SUBJECT TITLE: DROP STRUCTURE 1	CHECKED BY:	DATE:	CONTRACT NO.:	

DS1B.WK1

TRIAL 2 – FOR MINIMUM WALL STEEL

Reinforced Concrete Design

TRY 30" WALL, d = 25.5 IN ← GOOD
(to allow for batter)

Mn=As Fy (d–(As Fy /.85 F'c b) /2)

Input

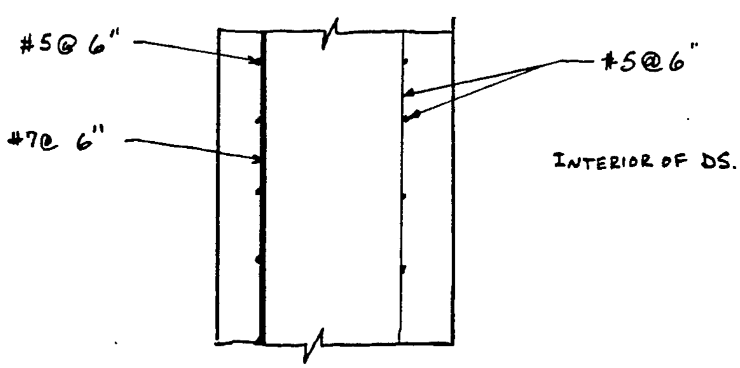
F'c =	4.0 ksi	a = Fy (Fy/(.85F'c b)/2)	44.12	(b^2–4ac)^.5 =	1437.93
Fy =	60.0 ksi	b = Fy d	1530.00	2a =	88.24
b =	12.0 in	c = Mn (12)/Phi	1548.47		
d =	25.5 in				
Mu =	116.1 k–ft	Beta 1 =	0.85		
Phi =	0.9				

Output

Rho min =	0.0033	–> 200/Fy
Rho max =	0.0071	–> .25 Rho bal
As min =	1.02 in^2	
As max =	2.18 in^2	
Rho req'd =	0.0034	–> As/bd
As req'd =	1.04 in^2	–> (b–(b^2–4ac)^.5)/2a
4/3 As =	1.39 in^2	

Design As : 1.04 in^2 <------ OK USE 30" THICK WALL USE #7 BARS @ 6"

TEMP & SHRNK = .0014 (12)(30) = 0.504 IN² USE #5 BARS @ 6"



US Army Corps of Engineers Saint Paul District	PROJECT TITLE: CHASKA – STAGE 3	COMPUTED BY: JHM	DATE: 09/03/93	SHEET: 23	OF: 40
	SUBJECT TITLE: DROP STRUCTURE 1	CHECKED BY:	DATE:	CONTRACT NO.:	

DETERMINE WALL THICKNESS: SECTION B–B AT LOWER WALL

MAX SHEAR = 5.3 K FROM LOAQD CASE 10 – DRAWDOWN (See Attached CFRAME Output)

Vu = DESIGN SHEAR = 5.3 (1.7)(1.3) = **11.71 K**

Vu = Phi b d 2 (F'c)^.5 ACI 318 SECTION 11

dmin = Vu/(Phi b 2 (F'c)^.5)= 11.71(1000)/(.85(12)(2)(63.25)) = 9.1 IN

d = 9.1 + 4 + .5 = 13.6 IN **TRY 24" WALL, d = 19.5 IN**
FOR BATTER = .75 IN/FT

DETERMINE MINIMUM WALL STEEL:

MAX MOMENT = 271.6 IN–K, FOR LOAD CASE 10 – DRAWDOWN, FROM CFRAME

Mu = DESIGN MOMENT = (271.6/12) (1.7)(1.3) = **50.0 FT–K**

Reinforced Concrete Design

Mn=As Fy (d–(As Fy /.85 F'c b) /2)

Input

F'c =	4.0 ksi	a = Fy (Fy/(.85F'c b)/2)	44.12	(b^2–4ac)^.5 =	1118.57
Fy =	60.0 ksi	b = Fy d	1170.00	2a =	88.24
b =	12.0 in	c = Mn (12)/Phi	666.93		
d =	19.5 in				
Mu =	50.0 k–ft	Beta 1 =	0.85		
Phi =	0.9				

Output

Rho min =	0.0033	–> 200/Fy
Rho max =	0.0071	–> .25 Rho bal
As min =	0.78 in^2	
As max =	1.67 in^2	
Rho req'd =	0.0025	–> As/bd
As req'd =	0.58 in^2	–> (b–(b^2–4ac)^.5)/2a
4/3 As =	0.78 in^2	

Design As : 0.78 in^2 <------ OK USE 24" THICK WALL ~~CONTINUE TO USE #7 @ 6"~~ use #6 @ 6" See sheet 38

TRANSITION FROM HIGH SIDE WALL TO LOW SIDE WALL BY MAINTAINING TOP OF SIDE WALLS AT 1'–3" ALSO MAINTAIN THE BATTER AT .75 IN/FT. VERTICAL REINFORCING AND TEMP & SHRINKAGE REINFORCING SHOULD REMAIN THE SAME FOR ENTIRE WALL.

18	18	19	11.80	.8000E+04	.2400E+03	.2400E+03	.3824E+04	.1634E+04
19	15	20	1.75	.7500E+08	.5040E+03	.5040E+03	.3824E+04	.1634E+04
20	20	21	11.80	.8000E+04	.2400E+03	.2400E+03	.3824E+04	.1634E+04

*** LOAD CASE 1 DEAD LOADS

MEMBER	DIRECTION	PROJECTED LOAD KIP / FT
1	Y	-.5250E+00
2	Y	-.5250E+00
3	Y	-.5250E+00
4	Y	-.5250E+00
5	Y	-.5250E+00
6	Y	-.5250E+00
7	Y	-.5250E+00
8	Y	-.5250E+00
9	Y	-.5250E+00
10	Y	-.5250E+00
11	Y	-.5250E+00
12	Y	-.5250E+00
13	Y	-.5250E+00
14	Y	-.5250E+00
15	Y	-.5250E+00
16	Y	-.5250E+00

JOINT	FORCE X KIP	FORCE Y KIP	MOMENT FT-KIP
18	.0000E+00	-.2900E+01	.0000E+00
20	.0000E+00	-.2900E+01	.0000E+00

*** LOAD CASE 2 MOIST SOIL LOADS

MEMBER	DIRECTION	PROJECTED LOAD KIP / FT
1	Y	-.1350E+01
16	Y	-.1350E+01

MEMBER	LA FT	PA KIP / FT	LB FT	PB KIP / FT	ANGLE DEG
18	.00	.6100E+00	11.80	.0000E+00	.00
20	.00	-.6100E+00	11.80	.0000E+00	.00

*** LOAD CASE 3 SURCHARGE

MEMBER DIRECTION PROJECTED LOAD

13	Y	-.6740E+00
14	Y	.1112E+01
15	Y	.1112E+01
16	Y	.1112E+01

MEMBER	LA FT	PA KIP / FT	LB FT	PB KIP / FT	ANGLE DEG
18	.00	-.6740E+00	10.80	.0000E+00	.00
20	.00	.6740E+00	10.80	.0000E+00	.00

*** LOAD CASE 6 EXTERIOR WATER 1

MEMBER	DIRECTION	PROJECTED LOAD KIP / FT
1	Y	.5300E+00
1	Y	-.3120E+00
2	Y	.5300E+00
3	Y	.5300E+00
4	Y	.5300E+00
5	Y	.5300E+00
6	Y	.5300E+00
7	Y	.5300E+00
8	Y	.5300E+00
9	Y	.5300E+00
10	Y	.5300E+00
11	Y	.5300E+00
12	Y	.5300E+00
13	Y	.5300E+00
14	Y	.5300E+00
15	Y	.5300E+00
16	Y	.5300E+00
16	Y	-.3120E+00

MEMBER	LA FT	PA KIP / FT	LB FT	PB KIP / FT	ANGLE DEG
18	.00	.3120E+00	5.00	.0000E+00	.00
20	.00	-.3120E+00	5.00	.0000E+00	.00

*** LOAD CASE COMBINATIONS ***

Load Case for Interior Water & Design Upl. ft does Not Apply.

LOAD CASE	1	2	3	4	5	6	7	8
	LOAD CASE FACTORS							
9	1.00	1.00	1.00	.00	.00	.00	.00	.00
10	1.00	.00	1.00	1.00	.00	1.00	.00	.00

1 LOAD CASE 9 DEWATERED

3	.0000E+00	-.1906E+00	-.1718E-04
4	-.3320E-04	-.1906E+00	.0000E+00
5	-.1660E-03	-.1896E+00	.3445E-04
6	-.2988E-03	-.1874E+00	.4737E-04
7	-.4316E-03	-.1850E+00	.4180E-04
[illegible]	-.5644E-03	-.1834E+00	.2396E-04
9	-.6972E-03	-.1828E+00	.0000E+00
10	-.8300E-03	-.1834E+00	-.2396E-04
11	-.9628E-03	-.1850E+00	-.4180E-04
12	-.1096E-02	-.1874E+00	-.4737E-04
13	-.1228E-02	-.1896E+00	-.3445E-04
14	-.1361E-02	-.1906E+00	.0000E+00
15	-.1394E-02	-.1906E+00	.1718E-04
16	-.1394E-02	-.1903E+00	.1591E-04
17	-.1394E-02	-.1901E+00	.1580E-04
18	.4970E-03	-.1906E+00	-.1720E-04
19	.4179E-01	-.1906E+00	-.3634E-03
20	-.1891E-02	-.1906E+00	.1720E-04
21	-.4319E-01	-.1906E+00	.3634E-03

STRUCTURE REACTIONS

JOINT	FORCE X KIP	FORCE Y KIP	MOMENT IN-KIP
1	.0000E+00	.9506E-01	.0000E+00
2	.0000E+00	.2379E+00	.0000E+00
3	.0000E+00	.2382E+00	.0000E+00
4	.0000E+00	.4766E+00	.0000E+00
5	.0000E+00	.7582E+00	.0000E+00
6	.0000E+00	.7494E+00	.0000E+00
7	.0000E+00	.7402E+00	.0000E+00
8	.0000E+00	.7335E+00	.0000E+00
9	.0000E+00	.7310E+00	.0000E+00
10	.0000E+00	.7335E+00	.0000E+00
11	.0000E+00	.7402E+00	.0000E+00
12	.0000E+00	.7494E+00	.0000E+00
13	.0000E+00	.7582E+00	.0000E+00
14	.0000E+00	.4766E+00	.0000E+00
15	.0000E+00	.2382E+00	.0000E+00
16	.0000E+00	.2379E+00	.0000E+00
17	.0000E+00	.9506E-01	.0000E+00
TOTAL	.0000E+00	.8789E+01	

1 MEMBER END FORCES

MEMBER	LOAD CASE	JOINT	AXIAL KIP	SHEAR KIP	MOMENT IN-KIP	MOMENT EXTREMA IN-KIP	LOCATION IN
1	9	1	.0000E+00	.3600E+00	.0000E+00	.3648E+00	1.92
		2	.0000E+00	.1765E+01	-.8430E+01	-.8430E+01	12.00
	10	1	.0000E+00	.9506E-01	.0000E+00	.3373E-01	.72
		2	.0000E+00	.1512E+01	-.8501E+01	-.8501E+01	12.00
2	9	2	.0000E+00	-.8648E+00	-.8430E+01	-.8430E+01	.00
		3	.0000E+00	.1652E+01	-.3108E+02	-.3108E+02	18.00
	10	2	.0000E+00	-.1274E+01	-.8501E+01	-.8501E+01	.00
		3	.0000E+00	.1267E+01	-.3137E+02	-.3137E+02	18.00
3	9	3	-.4944E+01	-.3652E+01	.3379E+03	.3379E+03	.00

31/401

	10	16	.0000E+00	.1512E+01	-.8501E+01	.3373E-01	11.28
		17	.0000E+00	.9506E-01	.0000E+00	-.8501E+01	.00
17	9	3	-.2900E+01	.4944E+01	-.3689E+03	-.2651E+03	21.00
		18	-.2900E+01	-.4944E+01	-.2651E+03	-.3689E+03	.00
	10	3	-.2900E+01	.5332E+01	-.3836E+03	-.2716E+03	21.00
		18	-.2900E+01	-.5332E+01	-.2716E+03	-.3836E+03	.00
18	9	18	.0000E+00	.4944E+01	-.2651E+03	.0000E+00	141.60
		19	.0000E+00	.0000E+00	.0000E+00	-.2651E+03	.00
	10	18	.0000E+00	$\boxed{.5332E+01}$	$\boxed{-.2716E+03}$	.0000E+00	141.60
		19	.0000E+00	.0000E+00	.0000E+00	-.2716E+03	.00
19	9	15	-.2900E+01	-.4944E+01	.3689E+03	.3689E+03	.00
		20	-.2900E+01	.4944E+01	.2651E+03	.2651E+03	21.00
	10	15	-.2900E+01	-.5332E+01	.3836E+03	.3836E+03	.00
		20	-.2900E+01	.5332E+01	.2716E+03	.2716E+03	21.00
20	9	20	.0000E+00	-.4944E+01	.2651E+03	.2651E+03	.00
		21	.0000E+00	.0000E+00	.0000E+00	.0000E+00	141.60
	10	20	.0000E+00	$\boxed{-.5332E+01}$	$\boxed{.2716E+03}$	.2716E+03	.00
		21	.0000E+00	.0000E+00	.0000E+00	.0000E+00	141.60

US Army Corps of Engineers Saint Paul District	PROJECT TITLE: CHASKA – STAGE 3	COMPUTED BY: JHM	DATE: 06/30/93	SHEET: 33	OF: 40
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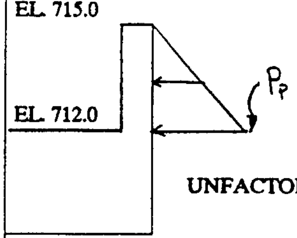
DS1C.WK1

DESIGN END SILL:

USE FULL PASSIVE, ASSUME SILL ACTS AS CANTILEVER DUE TO LENGTH/HEIGHT RATIO.



Kp = 3 Pg 3–4 EM 1110–2–2502

Pp = Kp (.114)(715.0–712.0) = 1.03 KSF

UNFACTORED { SHEAR = 1/2 (Pp) H = 1.54 K

MOMENT = 1/2 (Pp) H (H/3) = 1.54 FT–K }

EVALUATE 15" THICK END SILL (MIN CONSTRUCTABLE WITH 4" COVER)

d = 15 – 4 – .5 = 10.5 IN

Vn = Phi b d 2 (F'c)^.5 = 0.85(12)10.5(2)(4000)^.5 = 13.55 K

Vu = V (1.7)(1.3) = 1.54 (1.7)(1.3) = **3.40 K ≤ 13.55 K ∴ OK**

USE MIN STEEL FOR TEMP & SHRINKAGE

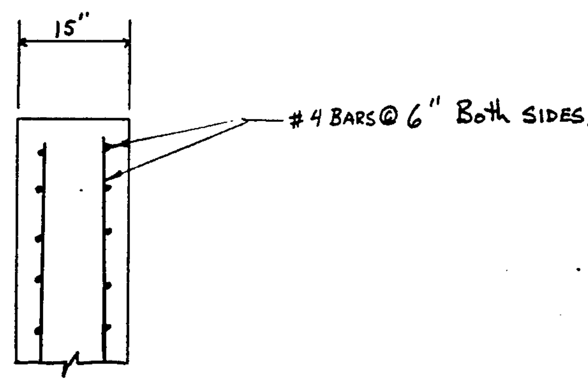
As = .0014 b D = .0014 (12)(15) = 0.252 IN^2

TRY #4 BARS @ 6" As = 0.40 IN^2
Rho = .40/(12 10.5) = .00317

CHECK MOMENT CAPACITY

Mu = Phi As Fy (d–(As Fy /.85 F'c b) /2) = .9(.40)(60)(10.5–(.40(60)/.85(4)12)/2)/12 = 18.37 FT–K

Mu = M (1.7)(1.3) = 1.54 (1.7)(1.3) = **3.40 FT–K ≤ 18.37 FT–K ∴ OK**



US Army Corps of Engineers Saint Paul District	PROJECT TITLE: CHASKA – STAGE 3	COMPUTED BY: JHM	DATE: 06/30/93	SHEET: 35	OF: 40
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DS1D.WK1

DETERMINE WEIGHTS AND FORCES: (PER FT OF WIDTH)

		FORCE (K)	MT ARM (FT)	MOMENT (FT–K)	
VERTICAL					
E1 = 40/47 (.127)(3)(719.0–712.0) =		2.3	41.0	93.1	
E2 = 1/47 (2)[42.5(723.8 – 712.0)((1 + 1.73)/2) .127] =		3.7	21.3	78.6	
E3 = 1/47 (2)[26.4(1/2)(732.2 – 723.8)((1.73 + 2.25)/2).127] =		1.2	33.7	40.2	
C1 = 1/47 (2)[18(732.2 – 723.8)((1.25 + 1.77)/2).150] =		1.5	33.5	48.8	
C2 = 1/47 (2)[8.4(1/2)(732.2 – 723.8)((1.25 + 1.77)/2).150] =		0.3	21.7	7.4	
C3 = 1/47 (2)[42.5(723.8 – 712.0)((1.77 + 2.5)/2).150] =		6.8	21.3	145.2	
C4 = (40/47)(.150)(1.25)(719.0 – 712.0) =		1.1	38.9	43.4	
C5 = .150 (42.5)(2.5) =		15.9	21.3	338.7	
C6 = (40/47)(.150)(1.25)(715.0 – 712.0) =	33.3	0.5	0.6	0.3	795.7
W1 = 40/47 (.0624)(37)(715.0 – 712.0) =		5.9	19.8	116.4	
U = –(42.5) .0624 ((8.49 + 6.30)/2) = (See Line of Creep below)		–22.7	22.3	–506.9	
NET WEIGHT		16.5			
HORIZONTAL					
Pw1 = –1/2 (.0624)(719.0 – 709.5)^2 =		–2.8	3.2	–8.9	
Po = –1/2 Ko (.127 – .0624)(719.0 – 709.5)^2 =		–1.3	3.2	–4.2	
MAX ALLOW FOR SLIDING .5Pp = 1/2 (1/2)(3)(.127 – .0624)(715.0 – 709.5)^2 =		1.5	1.8	2.7	
Pw2 = 1/2 (.0624)(715.0 – 709.5)^2 =		0.9	1.8	1.7	
SUM HORIZONTAL		–1.7			
NET OVERTURNING MOMENT				396.5	

LINE OF CREEP FOR UPLIFT:

TOT HEADd = 719.0 – ((9.5+5+5)/(9.5+5+5+42.5+5+5+5.5))(719.0 – 715.0) = 717.99

HEADd = 717.99 – 709.5 = 8.49 FT

TOT HEADe = 719.0 – ((9.5+5+5+42.5)/(9.5+5+5+42.5+5+5+5.5))(719.0 – 715.0) = 715.80

HEADe = 715.80 – 709.5 = 6.30 FT

US Army Corps of Engineers Saint Paul District	PROJECT TITLE: CHASKA – STAGE 3	COMPUTED BY: JHM	DATE: 06/30/93	SHEET: 37	OF: 40
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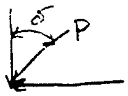
DS1D.WK1

$N_q = 26.09$ $\quad N = 26.17$ FOR Phi = 33° $\quad$ TABLE 5–1, EM 2502

$\xi_{qd} = 1 + .1(D/\bar{B})TAN(45^\circ+33^\circ/2) = 1 + .1(5.5/37.25)1.842 =$ $\quad$ 1.027

$\xi_{\gamma d} = \xi_{qd} =$ $\quad$ 1.027

N' = 33.3



δ = TAN ^ –1 (T/N') = 0°

T = 0

$\xi_{qi} = (1 - 0/90)$ ^ 2 = $\quad$ 1.00 $\qquad \xi_{qg} = \xi_{\gamma g}$ = (1 – TAN 0) ^ 2 = 1.00

$\xi_{\gamma i} = (1 - 0/33)$ ^ 2 = $\quad$ 1.00

$\xi_{qt} = \xi_{\gamma t}$ = (1 – (0) TAN 33) ^ 2 = $\quad$ 1.00

Q = 37.25 [(1.027)(1.00)(1.00)(0.63)(26.09) + (1.027)(1.00)(1.00)(37.25)(.114)(26.17)/2] =

= 2751.9 K/FT

FS = Q/N' = 2751.9/(16.5+22.7–5.9) = $\quad$ 82.6 $\geq$ 3.0 $\therefore$ OK

CHECK REGULAR LOADING CASE:

$\bar{B} = B - 2e = 42.5 - 2(3.33) =$ $\quad$ 35.83 FT $\quad$ Assume c = 0

$\xi_{qd} = 1 + .1(D/\bar{B})TAN(45^\circ+33^\circ/2) = 1 + .1(5.5/35.83)1.842 =$ $\quad$ 1.028

$\xi_{\gamma d} = \xi_{qd} =$ $\quad$ 1.028

N' = 16.5

δ = TAN ^ –1 (T/N') = $\quad$ 6.0°

T = 1.7

$\xi_{qi} = (1 - 6.0^\circ/90^\circ)$ ^ 2 = $\quad$ 0.871 $\qquad \xi_{qg} = \xi_{\gamma g}$ = (1 – TAN 0) ^ 2 = 1.00

$\xi_{\gamma i} = (1 - 6.0^\circ/33^\circ)$ ^ 2 = $\quad$ 0.669

$\xi_{qt} = \xi_{\gamma t}$ = (1 – (0.00) TAN 33) ^ 2 = $\quad$ 1.000

Q = 35.83 [(1.028)(0.871)(1.000)(0.63)(26.09) + (1.028)(0.669)(1.000)(35.83)(.114)(26.17)/2] =

= 1843.5 K/FT

FS = Q/N' = 1843.5 / 16.5 = $\quad$ 111.8 $\geq$ 3.0 $\therefore$ OK

US ARMY CORPS OF ENGINEERS SAINT PAUL DISTRICT	PROJECT TITLE: CHASKA STAGE 3	COMPUTED BY: JHM	DATE: 07/23/93	SHEET: 39	40
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REINFORCING STEEL DESIGN FOR HIGH WALL

WALL
(See Moment Graph)

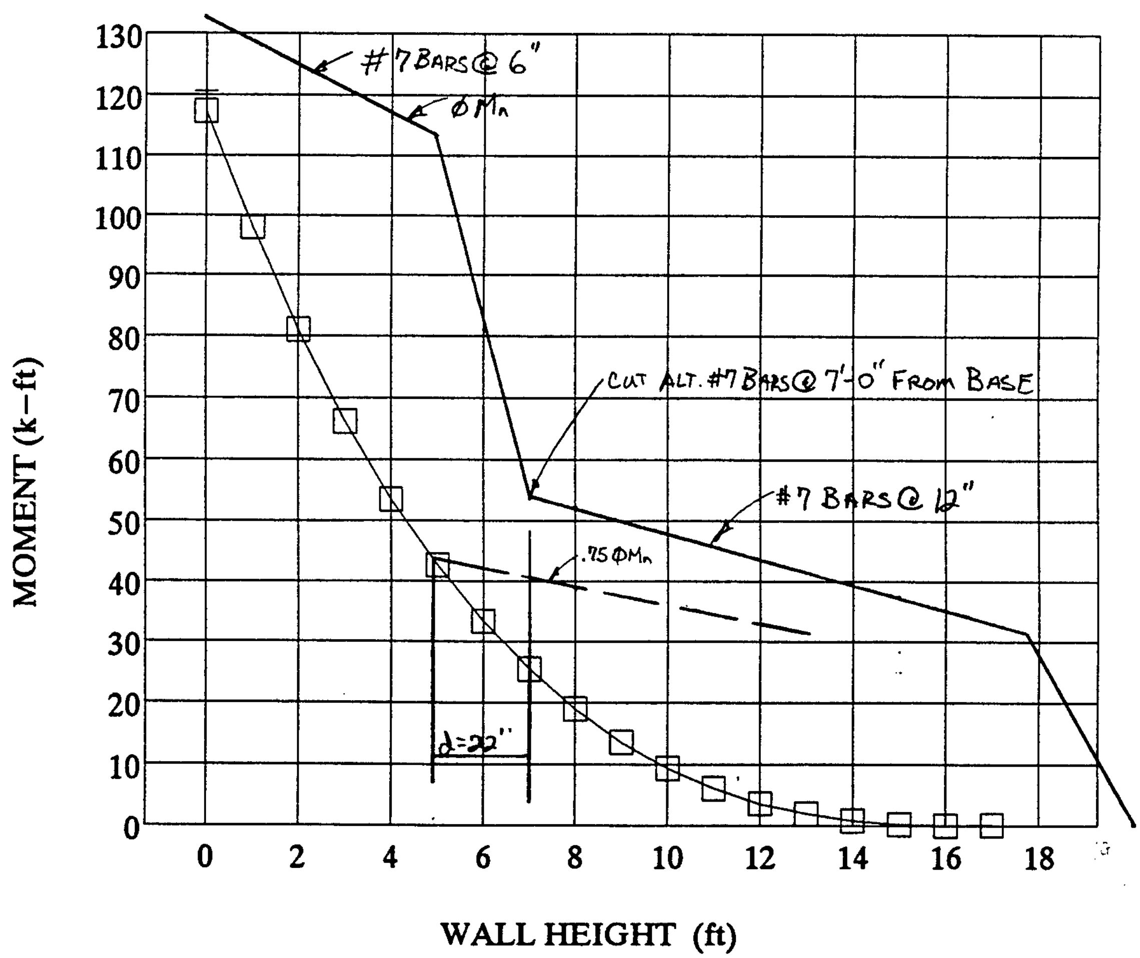
USE #7 BARS @ 6", As = 1.20 in^2
CUT ALT. #7 BARS @ 7 '- 0 " FROM BASE

TEMP & SHRINK As REQ'D/SIDE = 0.50 in^2
VERTICAL: USE #5 BARS @ 6" As = 0.62 in^2
HORIZONTAL: USE #5 BARS @ 6" As = .62 in^2

Mn = As Fy (d – (As Fy/(.85 f'c b))/2)

FROM BASE	f'c	Fy	b	d	As	Phi	Phi Mn	.75 Phi Mn
ft	ksi	ksi	in	in	in^2		k–ft	k–ft
0.00	4.0	60	12	25.65	1.20	0.9	133.75	
10.00	4.0	60	12	18.15	1.20	0.9	93.25	
8.00	4.0	60	12	19.65	0.60	0.9	51.86	38.90
15.00	4.0	60	12	14.40	0.60	0.9	37.69	28.27

WALL MOMENT GRAPH:



APPENDIX F

RECREATION, LANDSCAPE DEVELOPMENT
AND AESTHETIC CONSIDERATIONS

EAST CREEK AT CHASKA, MINNESOTA
STAGE 3 FEATURE DESIGN MEMORANDUM
FLOOD CONTROL PROJECT

CHASKA STAGE 3

APPENDIX F

RECREATION, LANDSCAPE DEVELOPMENT,
AND AESTHETIC CONSIDERATIONS

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REFERENCES

1. EM 1110-2-38, Environmental Quality in Design of Civil Works Projects.

2. EM 1110-2-301, Guidelines for Landscape Planting at FLoodwalls, Levees, and Embankment Dams.

EAST CREEK AT CHASKA, MINNESOTA
STAGE 3 FEATURE DESIGN MEMORANDUM
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APPENDIX F

RECREATION, LANDSCAPE DEVELOPMENT, AND AESTHETIC CONSIDERATIONS

RECREATION

1. A recreation trail will accommodate walkers, joggers, and cyclists. The new trail will begin at approximately station 16+00 where it ties into an existing trail. Following the west side of the channel, it will pass under Stoughton Avenue and U.S. Highway 212. Railing will provide protection for the trial user at underpasses. Between Highway 212 and the drop structure at Station 33+00, berming, trees, and shrubs will create a park experience for the trail user and provide an attractive visual buffer for nearby home owners. North of the drop structure, the trail will be located on the top of the levee; and at the proposed alignment for Engler Avenue, the trail will be accessible from the street. Continuing, the trail will pass under the Engler bridge. On the north side of Engler, a twenty-car parking lot will accommodate trail users; and a walkway from the lot will connect to the trail. A kiosk will be located in this area. At the drop structure at station 52+00, the trail will divide. One route will continue along the top of the right bank levee and tie into an existing trail. The other will cross the drop structure and follow the left bank levee tying into another existing trail.

LANDSCAPE DEVELOPMENT AND AESTHETIC CONSIDERATIONS

2. Plantings will include trees, shrubs, native grasses and forbes; in selected areas, sod and turf grasses will be used. The removal of existing vegetation will impact wildlife as well as increase the visibility of the channel and levees. Consequently, the plant material for this project will have to be chosen to reflect the types and varieties of vegetation lost in each of several areas. The upstream end of the project will require replacement of a large number of trees. The west bank of the central portion will require trees, shrubs, and grasses compatible with suburban residential areas while the east bank should receive trees, shrubs, grasses and forbes suitable to wildlife found in the area. The downstream end of the project crosses a fen which will dictate a specific combination of suitable plant material.

APPENDIX G

CONSTRUCTIBILITY

EAST CREEK AT CHASKA, MINNESOTA
STAGE 3 FEATURE DESIGN MEMORANDUM
FLOOD CONTROL PROJECT

APPENDIX G

CONSTRUCTIBILITY

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EAST CREEK AT CHASKA, MINNESOTA
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APPENDIX G

CONSTRUCTIBILITY

INTRODUCTION

1. This appendix presents the construction aspects of the proposed flood control improvements on East Creek at Chaska, Minnesota. Information is presented on major construction activities, scheduling, water control, utility modifications, traffic considerations, construction material, and disposal areas.

MAJOR CONSTRUCTION ACTIVITIES

2. Stage 3 of the flood control project consists primarily of a diversion channel that protects Chaska from flooding of East Creek. The work includes the following major construction activities:

a. Excavations of about 300,000 CY of channel.

b. Construction of about 30,000 CY of riprap and bedding.

c. Construction of about 60,000 CY of impervious levee.

d. Construction of 4 concrete drop structures.

e. Construction of 2 gatewells with concrete pipe.

f. Construction of 3 roadway bridges.

g. Construction of 12,000 SY of articulated concrete.

h. Construction of 630 LF of 12' x 12' concrete box culvert.

These activities can be accomplished using ordinary construction equipment and methods.

CONSTRUCTION SCHEDULING CONSIDERATIONS

3. The construction of this project is scheduled to start in February 1995 and be completed in December 1996. The construction contractor will be responsible for the construction schedule and be required to prepare and receive approval on a network analysis system that shows his proposed construction schedule. Construction items that will require special consideration include:

WATER CONTROL

GROUND WATER

5. It is expected that dewatering wells or wellpoints will be required to lower the ground water level for all 4 drop structures and the channel between Stations 35+00 and 51+00.

RIVER WATER

6. It is anticipated that the downstream portion of the articulated concrete will be constructed underwater.

UTILITY MODIFICATION SCHEDULE

7. Table G-1 summarizes the required telephone, electric, gas, sewer, water, etc., utility modifications required.

TABLE G-1
UTILITY MODIFICATION SCHEDULE

Minnegasco

Approximate Station	Facility	Relocate
* 12+00	6" steel 450 psi	200'
17+00	8" steel 95 psi	150'
17+00	3" steel 50 psi	150'
20+00 to 25+00	8" steel 95 psi	500'
* 52+00	8" steel 95 psi	300'

United Telephone System
* 1) Stoughton Avenue crossing
  2) County Road 17 & TH 212
* 3) South of Engler
  4) County Road 17 crossing
* 5) Brandondale Trailer Park

City of Chaska Power
* Between Stoughton & TH 212
* County Road 17
* Brandondale Trailer Park

Sewer and Water Utility Relocations
* Hazeltine Interceptor
* County Road 17 water main
* Brandondale water service
* Sanitary sewer lift stations (2)
* Revise miscellaneous piping

Minnesota Valley
* Power Poles Station 41+00

Those indicated with and asterisk are included in project cost. Additional possible utility modifications are included on pages H-7 and H-8 of Appendix H, Cost Estimate.

14. Random fill, 85,000 CY inplace volume. This fill material must be placed so that it does not cause channel stability, settlement, seepage or drainage problems.

a. About 37,000 CY will be deposited east of and adjacent to the channel at Station 40+00 in a triangular area 500' x 500' x 8' deep.

b. About 7,000 CY will be deposited west of and adjacent to the channel at Station 39+00 in a triangular area 200' x 480' x 4' deep.

c. About 26,000 CY will be deposited about 500' east of channel at Station 20+00 between Stoughton and the railroad track in an area 400' x 500' x 3.5' deep.

d. Use 15,000 CY for landscaping overbuild.

15. Unsatisfactory material above water table 30,200 CY inplace. Deposit offsite in disposal area provided by local sponsor.

16. Unsatisfactory material below water table, 53,200 CY inplace. Deposit offsite in disposal area provided by local sponsor.

APPENDIX H

COST ESTIMATE

EAST CREEK AT CHASKA, MINNESOTA
STAGE 3, FEATURE DESIGN MEMORANDUM
FLOOD CONTROL PROJECT

APPENDIX H

COST ESTIMATE

1. This is a summary of the current working estimate presented in accordance with EC 1110-2-538, "Civil Works Project Cost Estimating Code of Accounts", and EC 1110-2-263, Civil Works Construction Cost Estimating". It has been prepared as part of the DM for the Chaska Flood Control Project at Chaska, Minnesota. A detailed estimate has been prepared using the MCACES GOLD estimating computer program.

DESCRIPTION OF WORK

2. The project provides 5500 CFS level of protection and consists of a 6000 LF diversion channel, 4 drop structures, 3 bridges, 2 sanitary lift stations, electrical power lines, channel excavation, lime excavation, pervious fill, drainage fill, impervious fill, dewatering, outlet D, outlet E, articulated concrete, bedding, riprap, landscaping and other related work. The following are major items of work:

a. Bridges and Hwy. 41 Relocation -by others

b. Channel Excavation

c. Articulated Concrete

CONSTRUCTION METHODS

3. Standard construction methods will be employed for the entire project. Unique or expensive construction methods will not be required. Typical equipment consists of hydraulic excavators, cranes, trucks, dozers, rollers/compactors, motorgraders,and other related equipment.

4. Construction for the channel excavation will include various types of equipment and methods of construction. Construction for

estimates provided by the City of Chaska and by the COE. The city obtained information from the local utilities and affected private owners as necessary. Contingencies for the gas relocations are 100% due to limited information. Contingencies for telephone related work are 20%. Contingencies for City power are at 20%. Contingencies for water utilities are at 20%. Contingencies for bridges are at 5%. These contingencies are for City provided costs only. Other contingencies for this code of account are contingencies for quantities provided by COE and appear in the estimate.

c. 09.-.-.- Channels and Canals: Contingencies are 40% for lime excavation due to the uncertainties in the extent, disposal and content of the material. Other contingencies such as articulated concrete are 45% due to higher level of uncertainty. The 45% contingency for dewatering is due to the uncertainty of dewatering required. Most other items of work have contingencies of 25% or less.

d. 11.-.-.- Levees and Floodwalls: Contingencies are generally at 25% or more for all items of work.

e. 14.-.-.- Recreation Facilities: Contingencies are 30% or less for all items of work.

f. 30.-.-.- Planning, Engineering and Design: Costs and contingencies are provided by each separate engineering function and are based on experience with past projects. City portion of this cost is provided in the actual MCACES estimate.

g. 31.-.-.- Construction Management: Costs and contingencies are provided by Construction Division and are based on experience with past projects. City portion of this cost is provided in the actual MCACES estimate.

ACCOUNT CODE	ITEM	UNIT	ESTIMATED QUANTITY	UNIT PRICE	AMOUNT	CONTINGENCIES AMOUNT	%	REASON
01.-.-.	LANDS AND DAMAGES							
01.B.-.	ACQUISITION							
01.B.2.	BY LOCAL SPONSOR	OSP	38	700.00	26,600	4,000	15%	2,3,4
01.B.4.	GOVT. REVIEW OF LS ACTIVITIES	OSP	38	315.00	12,000	1,800	15%	2,3,4
01.C.-.-	CONDEMNATIONS							
01.C.2.-	BY LOCAL SPONSOR	TRT	4	1,000.00	4,000	600	15%	2,3,4
01.C.2.-	GOVT. REVIEW OF LS ACTIVITIES	TRT	4	200.00	800	100	15%	2,3,4
01.E.-.-	APPRAISALS							
01.E.3.-	BY LOCAL SPONSOR	OSP	38	500.00	19,000	2,900	15%	2,3,4
01.E.3.-	GOVT. REVIEW OF LS ACTIVITIES	OSP	38	250.00	9,500	1,400	15%	2,3,4
01.F.-.-	PL 91-646 ASSISTANCE							
	PL 91-646 RELOCATIONS - LOCAL SPONSOR	OSP	11	42,900	471,900	0	0%	1
01.R.-.	REAL ESTATE RECEIPT/PAYMENTS							
01.R.1.-	LAND PAYMENTS							
01.R.1.A	BY LOCAL SPONSOR	LS	1	733,800.00	733,800	110,400	15%	2,3,4
01.R.3.-	DAMAGE PAYMENTS							
01.R.3.B	BY LOCAL SPONSOR	LS	1	224,400.00	224,400	33,400	15%	2,3,4
	Subtotal, Lands and Damages				1,502,000			
	Contingency		10.3%			155,000		
	Subtotal, Lands and Damages plus Contingency					1,657,000		

REASON FOR CONTINGENCY

1. Not Applicable
2. Unknowns due to legal cost
3. Unknowns due to land prices
4. Unknowns due to qunatities

NOTES

1. Federal, Non-federal cost to be in accordance with 1986 WRDA
2. Unit prices are at April 1991 price level
3. TRT = Tract
4. OSP = Ownership
5. LS = Lump Sum

ACCOUNT CODE	ITEM		UNIT	ESTIMATED QUANTITY	UNIT PRICE	AMOUNT	CONTINGENCIES AMOUNT	%	REASON
02.1.J.B	CIP CONCRETE TEST PILES		EA	4	2,000.00	8,000	400	5%	1
02.1.J.B	CIP CONC PILE DRIVEN		LF	2,640	3.00	7,920	400	5%	1
02.1.J.B	CIP CONC PILE DELIVERED		LF	2,640	17.00	44,880	2,200	5%	1
02.1.K.B	STRUCTURE CONCRETE 1A43		CY	122	200.00	24,400	1,200	5%	1
02.1.K.B	STRUCTURE CONCRETE 3Y43		CY	282	260.00	73,320	3,700	5%	1
02.1.K.B	SPIRAL REINFORCMENT		LB	1,900	0.90	1,710	100	5%	1
02.1.L.C	REINFORCMENT BARS		LB	6,800	0.40	2,720	100	5%	1
02.1.L.C	REINF. BARS EPOXY		LB	84,000	0.48	40,320	2,000	5%	1
02.1.L.C	BRIDGE SLAB CONCRETE		SF	6,425	5.00	32,125	1,600	5%	1
02.1.L.C	SIDEWALK CONCRETE		SF	1,842	4.50	8,289	400	5%	1
02.1.L.C	RAILING CONCRETE TYPE F		LF	257	35.00	8,995	400	5%	1
02.1.L.C	BRIDGE APPROACH PANELS		SY	160	80.00	12,800	600	5%	1
02.1.L.C	PRESTRESSED CONC. BEAM		EA	21	3,280.00	68,880	3,400	5%	1
02.1.L.C	DIAPHRAGMS TYPE 28M		LF	270	50.00	13,500	700	5%	1
02.1.L.E	ORNAMENTAL RAILING		LF	257	100.00	25,700	1,300	5%	1
02.1.L.E	EXPANSION JOINT TYPE 4		LF	100	75.00	7,500	400	5%	1
02.1.L.E	BEARING ASSEMBLY		EA	42	500.00	21,000	1,100	5%	1
02.1.1.J	HIGHWAY 41 RELOCATION	929,300							
02.1.J.B	SITE PREPARATION		LS	1	20,000.00	20,000	1,000	5%	1
02.1.J.B	EXCAVATION		CY	21,000	1.50	31,500	1,600	5%	1
02.1.J.B	BACKFILL		CY	68,000	1.50	102,000	5,100	5%	1
02.1.J.B	BORROW		CY	47,000	4.50	211,500	10,600	5%	1
02.1.J.B	REMOVE EXISTING CULVERT		LS	1	10,000.00	10,000	500	5%	1
02.1.J.B	12 X 12 BOX CULVERTS		LF	628	600.00	376,800	18,800	5%	1
02.1.J.B	CULVERT INLETS		EA	2	15,000.00	30,000	1,500	5%	1
02.1.J.B	DEBRIS CONTROL STRUCTURE		LS	1	10,000.00	10,000	500	5%	1
02.1.J.B	INLET WEIR STRUCTURE		LS	1	10,000.00	10,000	500	5%	1
02.1.J.B	CULVERT OUTLETS		EA	2	15,000.00	30,000	1,500	5%	1
02.1.J.B	RIPRAP		CY	500	30.00	15,000	800	5%	1
02.1.J.B	ROAD SURFACE		LF	310	250.00	77,500	3,900	5%	1
02.1.J.B	SLOPE RESTORATION, SEED		LS	1	5,000.00	5,000	300	5%	1
02.3.2.Q	UTILITIES AND STREETS	1,102,734							
02.3.2.Q	GAS LINES 6" 450 PSI		LF	200	75.00	15,000	15,000	100%	1,2,3
02.3.2.Q	GAS LINES 8" 95 PSI		LF	300	50.00	15,000	15,000	100%	1,2,3
02.3.3.R	TELEPHONE STOUGHTON AVE		JOB	1	60,000.00	60,000	12,000	20%	1
02.3.3.R	TELEPHONE @ ENGLER AVE.		JOB	1	10,000.00	10,000	2,000	20%	1
02.3.3.R	TELE. @ TRAILER PARK		JOB	1	15,000.00	15,000	3,000	20%	1
02.3.3.R	CITY POWER HWY. 212		JOB	1	30,000.00	30,000	6,000	20%	1
02.3.3.R	CITY POWER HWY. 17		JOB	1	10,000.00	10,000	2,000	20%	1
	Mn. VALLEY P.P. STA. 41+00		JOB	1	12,000.00	12,000	2,400	20%	1
02.3.3.R	CITY POWER TRAILER PARK		JOB	1	15,000.00	15,000	3,000	20%	1
02.3.2.Q	HAZELTINE INTERCEPTOR		JOB	1	34,000.00	34,000	6,800	20%	1
02.3.2.Q	WATER MAIN HWY. 17		JOB	1	30,500.00	30,500	6,100	20%	1
02.3.2.Q	WATER @ TRAILER PARK		JOB	1	48,900.00	48,900	9,800	20%	1
02.3.2.Q	SANITARY SEWER LIFT STA		EA	2	70,000.00	140,000	28,000	20%	1
02.3.2.Q	MISCELLANEOUS PIPING		JOB	1	10,000.00	10,000	2,000	20%	1
02.1.2.B	ROAD RELOCATION		JOB	1	4,160.00	4,160	1,500	35%	1,3
02.1.R.B	REMOVE FENCE		JOB	1	325.00	325	100	35%	1,3
02.1.R.B	INSTALL FENCE		JOB	1	725.00	725	300	35%	1,3
02.3.2.Q	24" SEWER LINE		LF	210	45.00	9,450	3,300	35%	1,3

ACCOUNT CODE	ITEM		UNIT	ESTIMATED QUANTITY	UNIT PRICE	AMOUNT	CONTINGENCIES AMOUNT	%	REASON
09.-.-.-CHANNELS									
09.0.1.-	TRAFFIC CONTROL		JOB	1	12,900.00	12,900	1,300	10%	1,2,3
09.0.2.B	CLEARING AND GRUBBING		ACR	5	2,050.00	10,250	4,100	40%	1,2
09.0.2.B	STRIPPING		CY	15,290	0.79	12,079	2,400	20%	1,2
09.0.2.B	CHANNEL EXCAVATION		CY	225,547	3.87	872,867	261,900	30%	1,2
09.0.2.B	LIME EXCAVATION		CY	74,620	3.57	266,393	106,600	40%	1,2
09.0.2.B	PERVIOUS FILL		CY	23,752	4.34	103,084	30,900	30%	1,2
09.0.2.B	DRAINAGE FILL		CY	10,357	31.65	327,799	98,300	30%	1,2
09.0.2.B	NON-FEDERAL IMPERVIOUS BORROW								
09.0.2.B	ROYALTY/MATERIAL PRICE		CY	19,875	0.75	14,906	4,500	30%	
09.0.2.B	FEDERAL IMPERVIOUS FILL		CY	46,446	3.55	164,883	49,500	30%	1,2,3
09.0.2.B	MAINTENANCE ACCESS		JOB	1	32,000.00	32,000	6,400	20%	1,2
09.0.2.B	DEWATERING		JOB	1	288,100.00	288,100	72,000	25%	1,2
09.0.2.B	BEDDING		CY	1,370	33.00	45,210	9,000	20%	1,2
09.0.2.B	R6 RIPRAP-12"		CY	15,827	24.00	379,848	76,000	20%	1,2
09.0.2.B	R12 RIPRAP-24"		CY	10,415	31.65	329,635	65,900	20%	1,2
09.0.2.B	R33 RIPRAP-48"		CY	5,460	30.40	165,984	33,200	20%	1,2
09.0.R.C	DROP STRUCTURE NO. 1	158,854							
09.0.R.C	EXCAVATION		CY	2,569	2.55	6,551	2,300	35%	1,2
09.0.R.C	FORMWORK- SLAB		SF	1,422	2.95	4,195	1,000	25%	1,2
09.0.R.C	FORMWORK- WALL		SF	8,817	4.25	37,472	9,400	25%	1,2
09.0.R.C	REBAR		LBS	74,122	0.57	42,250	10,600	25%	1,2
09.0.R.C	CONCRETE -SLAB		CY	304	78.55	23,879	6,000	25%	1,2
09.0.R.C	CONCRETE -WALLS		CY	273	81.20	22,168	5,500	25%	1,2
09.0.R.C	WATERSTOP		LF	421	7.55	3,179	1,000	30%	1,2
09.0.R.C	CURING COMPOUND		SF	10,528	0.15	1,579	200	10%	
09.0.R.C	BACKFILL		CY	1,902	2.30	4,375	1,500	35%	1,2
09.0.R.C	HANDRAIL		LF	235	56.20	13,207	3,300	25%	1,2
09.0.R.C	DROP STRUCTURE NO. 2	386,190							
09.0.R.C	EXCAVATION		CY	7,750	2.55	19,763	6,900	35%	1,2,3
09.0.R.C	FORMWORK- SLAB		SF	2,480	2.85	7,068	1,800	25%	1,2
09.0.R.C	FORMWORK- WALL		SF	22,262	4.00	89,048	22,300	25%	1,2
09.0.R.C	REBAR		LBS	202,080	0.57	115,186	28,800	25%	1,2
09.0.R.C	CONCRETE -SLAB		CY	655	78.55	51,450	12,900	25%	1,2
09.0.R.C	CONCRETE -WALLS		CY	756	81.30	61,463	15,400	25%	1,2
09.0.R.C	WATERSTOP		LF	668	7.60	5,077	1,500	30%	1,2
09.0.R.C	CURING COMPOUND		SF	24,306	0.15	3,646	400	10%	
09.0.R.C	BACKFILL		CY	6,815	2.30	15,675	5,500	35%	1,2
09.0.R.C	HANDRAIL		LF	317	56.20	17,815	4,500	25%	1,2
09.0.R.C	DROP STRUCTURE NO. 3	269,985							
09.0.R.C	EXCAVATION		CY	5,904	2.55	15,055	5,300	35%	1,2,3
09.0.R.C	FORMWORK- SLAB		SF	1,812	2.85	5,164	1,300	25%	1,2
09.0.R.C	FORMWORK- WALL		SF	13,975	4.00	55,900	14,000	25%	1,2
09.0.R.C	REBAR		LBS	135,763	0.57	77,385	19,300	25%	1,2
09.0.R.C	CONCRETE -SLAB		CY	465	78.70	36,596	9,100	25%	1,2
09.0.R.C	CONCRETE -WALLS		CY	484	81.80	39,591	9,900	25%	1,2
09.0.R.C	WATERSTOP		LF	602	7.50	4,515	1,400	30%	1,2
09.0.R.C	CURING COMPOUND		SF	16,318	0.15	2,448	200	10%	

ACCOUNT CODE	ITEM	UNIT	ESTIMATED QUANTITY	UNIT PRICE	AMOUNT	CONTINGENCIES AMOUNT	%	REASON
09.0.2.B	SHRUBS	EA	350	87.10	30,485	6,100	20%	1,2
09.0.2.B	OVERBUILD FOR TREES	CY	15,310	3.05	46,696	18,700	40%	1,2
09.0.2.B	STRIPPING	CY	1,270	1.10	1,397	600	40%	1,2
0	TOPSOIL	CY	940	3.00	2,820	1,100	40%	1,2
	Subtotal, Channels and Canals				5,535,821			
	Contingency		28%			1,562,800		
	Subtotal, Channels and Canals plus Contingency					7,098,621		

REASON FOR CONTINGENCY

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1. Quantity or Product Variations
2. Unit Price or Price Uncertainties
3. Unknown Site Conditions

NOTES

ACCOUNT CODE	ITEM	UNIT	ESTIMATED QUANTITY	UNIT PRICE	AMOUNT	CONTINGENCIES AMOUNT	%	REASON
14.-.-.-RECREATION								
14.0.A.-	MOB, DEMOB, PREPATORY	JOB	1	1,700.00	1,700	300	20%	1,2
14.0.1.B	STRIPPING	CY	177	0.70	124	0	20%	1,2
14.0.1.B	EXCAVATION	CY	1,130	2.05	2,317	700	30%	1,2,3
14.0.1.B	FILL	CY	8	1.90	15	0	30%	1,2
14.0.1.B	AGGREGATE BASE COURSE	CY	298	15.00	4,470	900	20%	1,2
14.0.1.B	CURB & GUTTER	LF	330	12.60	4,158	800	20%	1,2
14.0.1.B	CONCRETE SIDEWALK	SF	1,320	3.50	4,620	900	20%	1,2
14.0.1.B	BITUMINOUS PAVEMENT	SY	8,690	4.20	36,498	9,100	25%	1,2
14.0.1.B	TOPSOIL	CY	44	10.00	440	100	25%	1,2
14.0.1.B	SEEDING	ACR	0.11	1,100.00	121	0	25%	1,2
14.0.1.B	KIOSK WITH SIGN	LS	1	4,000.00	4,000	1,200	30%	1,2
	Subtotal, Recreation Facilities				58,463			
	Contingency		24%			14,000		
	Subtotal, Recreation Facilities plus Contingency					72,463		

REASON FOR CONTINGENCY

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1. Quantity or Product Variations
2. Unit Price or Price Uncertainties
3. Unknown Site Conditions

NOTES

ACCOUNT CODE	ITEM	UNIT	ESTIMATED QUANTITY	UNIT PRICE	AMOUNT	CONTINGENCIES AMOUNT	%	REASON
	Subtotal, Planning, Engineering and Design plus Contingency					2,470,200		

REASON FOR CONTINGENCY

1. Quantity or Product Variations

APPENDIX J

HIGHWAY 41 / EAST CREEK

RELOCATIONS

TABLE OF CONTENTS

INTRODUCTION

Appendix J investigates hydraulic structures at Trunk Highway 41 (T.H. 41) and East Creek north of old downtown Chaska. The future upgrade of T.H. 41 and the design of the Stage 3 East Creek Diversion Channel have raised the need for a hydrologic and hydraulic evaluation of the T.H. 41 crossing. The Minnesota Department of Transportation (MnDOT) requires an analysis confirming the safety of the highway and areas immediately upstream and downstream. The Army Corps of Engineers requires the analysis because of the impact of a T.H. 41 hydraulic structure on the East Creek Ravine and the Flood Control Stage 3 Project.

Based on the requirements associated with T.H. 41, the City of Chaska has requested an evaluation of possible hydraulic structure alternatives for the T.H. 41 crossing of East Creek. The location of the T.H. 41 watershed is shown on Plate J-1, and on Plate A-1 and A-2 of Hydrology Appendix A.

The main objective of this appendix is to recommend the most hydraulically efficient and cost-effective crossing structure for T.H. 41 that meets MnDOT and Corps of Engineers safety standards.

Three previously conducted studies are referenced by this appendix: *The Lake Grace Dam Failure Analysis (1990)*, *The Lake Grace Dam Final Improvements (1993)*, and *The City of Chaska Stormwater Management Plan (1990)*.

This appendix describes the analysis of the alternatives, evaluates the alternatives using established criteria, and proposes a future hydraulic structure.

WATERSHED DESCRIPTION

The watershed contributing to T.H. 41 and the associated hydrologic properties is described in Hydrology Appendix A.

Three structures were initially considered:

1. A Bridge
2. New or additional culverts
3. A Benton-Boogen Arch (Be-Bo)

The Be-Bo was not considered feasible based on construction requirements. The amount of estimated overburden eliminated this alternative from further investigation. The bridge and culvert configurations were pursued as viable alternatives.

The following sections of this appendix discuss the alternatives in terms of hydraulic results, construction time frames, and construction costs.

HYDRAULIC RESULTS

A. Modeling Evaluation

In the evaluation of the alternatives, the following criteria were observed.

The selected alternative must:

1. Maintain a reasonable water elevation differential across the T.H.41 embankment.

2. Include the possibility of accommodating a pedestrian path under T.H. 41.

3. Address the need for scour protection upstream and downstream of T.H. 41.

4. Be based on a the future T.H. 41 embankment approximately 36 feet high and 90 feet wide, with 3:1 side slopes.

Additional criteria were established for alternatives which included culverts.

The culvert alternative must:

1. Maintain open channel flow throughout the modeled storm event.

2. Maintain the inverts of the culverts at similar elevations.

3. Include an appropriate debris barrier upstream of the culvert entrances.

Location	Peak Flow Rate (cfs)	Maximum Water Elevation
Upstream of T.H. 41 (Case 1)	3,830	878.8
Upstream of T.H. 41 with 50% plugging (Case 2)	3,830	884.7
Downstream of T.H. 41 (Case 1)	1,480	-
Downstream of T.H. 41 with 50% plugging (Case 2)	860	-
At Diversion Channel Inlet (Case 1)	4,400	-
At Diversion Channel Inlet with 50% plugging (Case 2)	3,820	-

TABLE J-2. TR-20 model results for Cases 1 and 2.

1. Hydraulic Head Differential

The hydraulic head across the T.H. 41 embankment represents a major concern with the present culvert. The existing highway embankment elevation is at 882.0. The modeled SPF produces a maximum water level 878.8. The head across the embankment would be approximately 25 feet. If the culvert were 50% plugged, the maximum water level would increase to 884.7 which would overtop the roadway. This would endanger the safety of the roadway, and upstream flooding could occur. The backwater effect produced under this assumption at Lake Grace Dam is also unacceptable in that it would substantially increase the chances of a sequence of dam breaks that would produce substantial downstream damage.

2. Other Factors

Other factors create a need for the replacement of the present hydraulic structure. The current culvert would not maintain open channel flow under SPF conditions. Because the current embankment is not wide enough to support a MnDOT highway expansion project and will be replaced and expanded there is an opportunity to increase the hydraulic capacity.

4. Other Factors

Energy dissipation is not needed under this alternative. The cross-section of the excavated embankment maintains approach flow velocities. Some scour protection at exposed bridge supports would be required.

Pedestrian traffic could easily be accommodated with this alternative. The high clearance under the bridge provides flexibility in locating the pedestrian trail.

D. The New Culvert Alternative (Case 4)

This alternative consists of two 12' x 12' box culverts, one to serve as a primary culvert and the other as a pedestrian culvert. The primary culvert serves as the main hydraulic channel, and the pedestrian culvert serves as a pedestrian tunnel and a hydraulic channel during major storm events. Plate J-5 illustrates the site plan of the two-culvert system.

1. Culvert Description

Primary Culvert

The proposed primary culvert orientation lies perpendicular to T.H. 41, reflecting the existing flow route. The culvert length of approximately 320 feet is based on future embankment slopes of 3:1. The upstream invert matches the creek-bed elevation of 850.0. The slope is 1.0 percent corresponding to the natural grade through the ravine.

Pedestrian Culvert

The proposed pedestrian culvert remains dry during storm events with a recurrence interval less than 100 years. The design length of 308 feet measures 12 feet shorter than the primary culvert. The invert elevation is 852.0 and the slope is 0.375 percent. The inlet of the pedestrian culvert is offset approximately 14 feet north of the primary culvert. The distance aids in culvert separation during small storm events as discussed below. Approximately 4 feet separate the outlets of the two culverts. The invert of the pedestrian culvert outlets four feet above the invert of the primary culvert.

Description of the Inlet (Efficient Culvert Inlets)

The design of culvert inlets promote efficient flow into the culvert (entrance loss coefficient equal to 0.2) by providing smooth transition flow lines. Wingwalls at 45 degrees with respect to the culvert wall were designed for all culvert inlets. In the hydraulic model, edges were considered to be rounded.

Plate J-5 shows the location of the East Creek debris deflector. The apex of the deflector is located 80 feet upstream of the inlet of the primary culvert. From the apex, one side reaches 80 feet to the northern point of the separation weir, continues across the pedestrian trail, and approximately 20 feet up the north embankment. The other side reaches 100 feet to the south side embankment. The piling used in the deflector rises to an elevation of 864.0, or 14 feet above the invert of the primary culvert. The proposed separation between pilings is 6 feet. The sides form an apex angle of approximately 80 degrees. The deflector provides 2,000 square feet of surface area which represents approximately 7 times the entrance area of the culverts.

This debris deflector requires periodic inspection and maintenance, including the removal of accumulated debris and the replacement of damaged members. The design operation and maintenance manual must outline an inspection schedule and procedure.

Description of the Outlet

Similar to the culvert inlets, an outlet separation must prevent flow from reentering the pedestrian culvert during small storm events. The outlet invert elevation of 850.6 provides four feet of clearance above the invert of the primary culvert. The downstream water elevation for a 100-year storm event is 3.7 feet, which established the four-foot differential between outlets. Plate J-7 illustrates the plan view of the outlet.

2. Peak Flows

Table J-4 lists the peak flows and maximum water elevations for the two-culvert alternative. This case includes two 12′ x 12′ box culverts with the SPF under fully developed conditions.

Location	Peak Flow Rate (cfs)	Maximum Water Elevation
Upstream of T.H. 41	3,830	863.4
Downstream of T.H. 41	3,380	855.8 (9.0 feet above the channel invert)
Diversion Channel	6,100	-

TABLE J-4. TR-20 model results for Case 4.

For the pedestrian culvert, the separation weir controls flows up to water elevation 860.0 (3.2 feet above the weir). Above this point, the culvert length and slope control the flow.

The maximum discharge of the hydraulic structure and the channel cross-sections determine the maximum tailwater elevation. The tailwater elevation peaks at nine feet above the downstream invert of the primary culvert. Tailwater does not limit the flow in either culvert.

Water Surface Elevations

The model reflected a maximum water elevation upstream of the culverts of 863.4. This elevation is 6.6 feet above the inlet separation weir, 1.4 feet above the crown of the primary culvert, and 0.6 feet below the crown of the pedestrian culvert.

The maximum water surface elevation assures open channel flow conditions in the pedestrian culvert regardless of the flow conditions because the water surface elevation never exceeds the crown elevation.

The 1.4 feet of water above the crown of the primary culvert does not assure either open channel flow or submerged flow conditions. Open channel flow is defined in this study as conditions in which the water surface does not come in contact with the crown of the culvert. Submerged flow conditions would be the converse. Literature sources indicate that the water surface will not come in contact with the crown of the culvert when the upstream water depth remains less than 1.2 times the diameter of the culvert (Henderson, Chow). This assumes that approaching flows increase in velocity and decrease in depth with critical flow and depth occurring at the entrance of the culvert. The application of this criterion implies that the water surface profile could rise to 864.4 (one foot higher than the modeled maximum water elevation) before the critical depth at the culvert entrance reaches the crown and submerged conditions occur.

Flow Conditions in the Culverts

The parameters listed in Table J-5 were used to analyze flow conditions in the proposed culverts.

Pedestrian culvert

Based on Manning's Equation, the flow in the culvert was approximately critical. The flow in this culvert does not make the transition into supercritical flow because of the lower culvert slope. The assumptions made with the primary culvert, therefore, cannot be applied to this culvert. However, the maximum upstream water level, 863.4, does not exceed the elevation of the crown, 864.0, which assures open channel flow.

The clearance at the pedestrian channel inlet could be expected to be even greater than the difference between the crown elevation and the maximum water level (0.6 feet). The critical flow condition in the culvert indicates that the entering flow increases in velocity and decreases in depth. If the flow approaches the critical depth, 7.4 feet, at the culvert inlet, 4.6 feet of clearance would be provided. This assumes that the inlet separation weir does not influence the location of the critical depth. At peak flow, the weir will be fully submerged, and will not control the flow into the pedestrian culvert or the water depth upstream of the culvert. The characteristics of the culvert control the water surface profile of the water entering the culvert.

6. Energy Dissipation

In order to minimize downstream erosion, the high discharge velocities from the culverts must be dissipated. The velocities at peak flow range from 7.0 to 10.0 feet per second based on the review of downstream channel cross-sections. The peak velocity of 24.4 feet per second from the primary culvert must be reduced to the downstream range in a controlled manner. An energy dissipator will be constructed to serve this function.

The flow in the primary and pedestrian culverts is supercritical and critical, respectively. At peak flow, the primary culvert conveys approximately 60 percent of the flow. The energy dissipator merges the flow from both outlets and provides a transition area for the flow to pass into subcritical flow.

Previously, Plate J-7 presented the plan view of the outlet. Plate J-8 illustrates the profile view of the energy dissipator. The initial 20 feet of the outlet apron continues at the same slope as the primary culvert, 1.0 percent. A flat apron directs flow from the pedestrian culvert towards the main channel. The apron also serves as an entrance landing for a pedestrian path. A sloped surface connects the aprons of the two culverts. The two aprons provide approximately a one second residence time for the flows from the outlets to merge. The aprons and all other channel bottom surfaces upstream of the energy dissipator will be constructed with

7. Operation Time

Plates J-2 and J-9 show the inflow and outflow hydrographs at T.H. 41, respectively. Comparison of the two hydrographs illustrates the decrease in peak flow due to the culverts.

Plate J-10 presents the water elevations upstream of T.H. 41 during the SPF. This figure provides information to determine the hydraulic operation time of the pedestrian culvert under SPF conditions. The water surface elevation exceeds the weir elevation of 856.8 for approximately 6.3 hours.

CONSTRUCTION DURATION

A. General

Both proposed alternatives will require permits from the Army Corps of Engineers and the Department of Natural Resources.

B. Duration

T.H. 41 represents a vital transportation and utility corridor for the City of Chaska. Disruption of this corridor impacts a variety of City services. The removal of T.H. 41 from service is obviously undesirable; therefore, a short construction schedule becomes another factor in selecting a T.H. 41 hydraulic structure.

Construction of the culverts offers an advantage over a conventional bridge structure relative to the length of construction. Culverts can be constructed in a significantly shorter time period.

A conventional bridge structure of this type normally requires 5 to 6 months for construction. Incentive clauses in the construction documents can shorten this time. However, 4 months is an optimistic schedule for a bridge of this size.

Culverts can be constructed in a significantly shorter period of time than conventional bridge structures. This project will require 2 to 3 months for construction of the proposed culvert alternative. Incentive clauses could shorten the construction time even further. A recent project in Chaska of similar magnitude was completed in less than 4 weeks under an emergency situation.

ESTIMATED COSTS

The cost of the alternatives serves as the final criterion in evaluating alternatives. Construction cost estimates were completed to facilitate the accurate comparison of alternative

	Cost Estimate for the Bridge	Amount
1.	Site preparation and removals	$ 20,000
2.	Excavation = 21,000 CY x $ 2.50	$ 52,500
3.	Haul fill = 21,000 CY x $ 4.00	$ 84,000
4.	Remove existing culvert	$ 10,000
5.	Bridge structure = (340' x 84') x $ 55	$ 1,570,800
6.	Slope restoration, seed	$ 5,000
	TOTAL	**$ 1,742,300**

TABLE J-8. Cost estimate for the proposed bridge alternative

As indicated in Tables J-7 and J-8, the proposed culvert require a significantly lower investment. The difference between the two alternatives is $813,000.

RECOMMENDATIONS AND CONCLUSIONS

The alternative selection is based on three subjects discussed in this report: The hydraulic benefits upstream and downstream of T.H. 41, the construction time frame, and the cost of the hydraulic structure.

A. Hydraulic Comparison

1. Upstream of and near T.H. 41

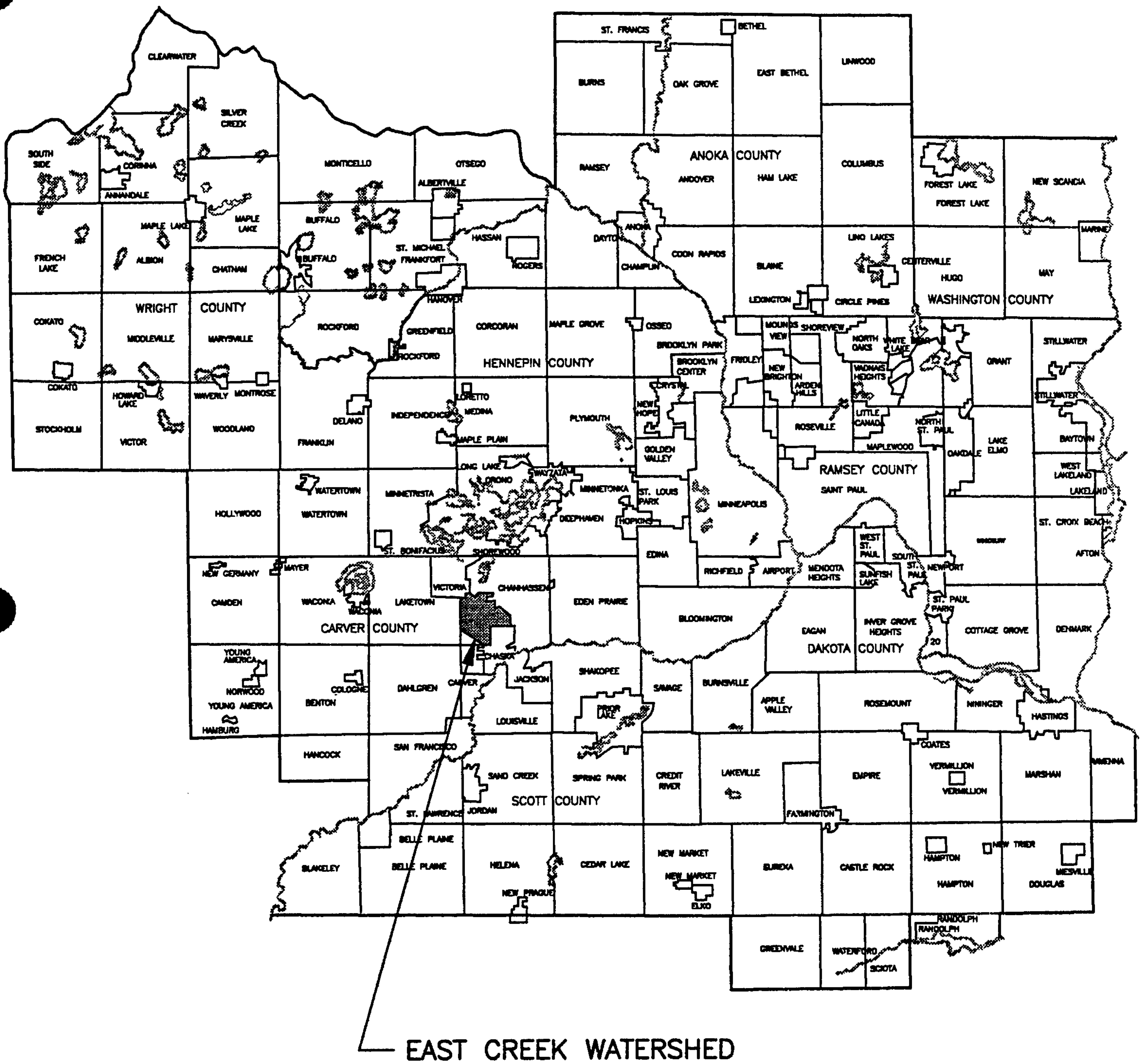
The bridge alternative does not produce upstream ponding. All flow passes underneath the bridge with no accumulation of debris. The new culvert alternative produces upstream ponding approximately 13.4 feet in depth. The increase in upstream ponding caused by the culverts is not significant. An additional 5.0 acres would be flooded upstream, and no property damaged. For the culvert alternative, the collection of debris behind the debris deflector would have to be cleaned periodically, particularly after major storm events.

The bridge would maintain the approaching channel velocities. The culvert alternative would increase flow velocities in the vicinity of the inlets and outlets. The culvert would require the construction of an energy dissipator.

	Culvert Alternative	Bridge Alternative
Hydraulic Performance (Upstream of and at T.H. 41)	- Upstream Ponding - Debris Control Required - Energy Dissipator Required - Tunnel Pedestrian Path	- No Upstream Ponding - No Debris Barrier - No Energy Dissipator - Open Pedestrian Path **RECOMMENDED**
Hydraulic Performance (Downstream of T.H. 41)	- Decreased flow in downstream and diversion channels - Increased protection for the City of Chaska **RECOMMENDED**	- Increased flow at the diversion channel - Downstream improvements required or lower protection rating of diversion channel
Construction Requirements	- T.H. 41 will be closed for 2 to 3 months **RECOMMENDED**	- T.H. 41 will be closed for 5 to 6 months
Construction Costs	- All requirements for this alternative will cost $ 929,000 **RECOMMENDED**	- All requirements for this alternative will cost $ 1,742,300

TABLE J-9. Comparison of Alternatives

The culvert alternative is the most beneficial from a hydraulic, construction, and economic perspective. The bridge alternative does provide benefits with no upstream ponding, no debris control requirement, and no energy dissipation structure. However, these advantages do not overcome the advantages of the culvert alternative. The culvert provides hydraulic benefits to the Diversion Channel, a shorter time of construction, and the significantly lower cost. Also, the disadvantages of the culvert alternative can be accommodated through the proper design of a debris control structure and energy dissipator. The upstream ponding produced by the culverts is not extensive and does not create the threat of upstream flooding and property damage. To ensure upstream safety, development should not occur below an elevation of 864.0.



LOCATION MAP

CITY OF CHASKA

PLATE J–1

TRUNK HIGHWAY 41 HYDRAULIC STRUCTURE

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Bonestroo
Rosene
Anderlik &
Associates

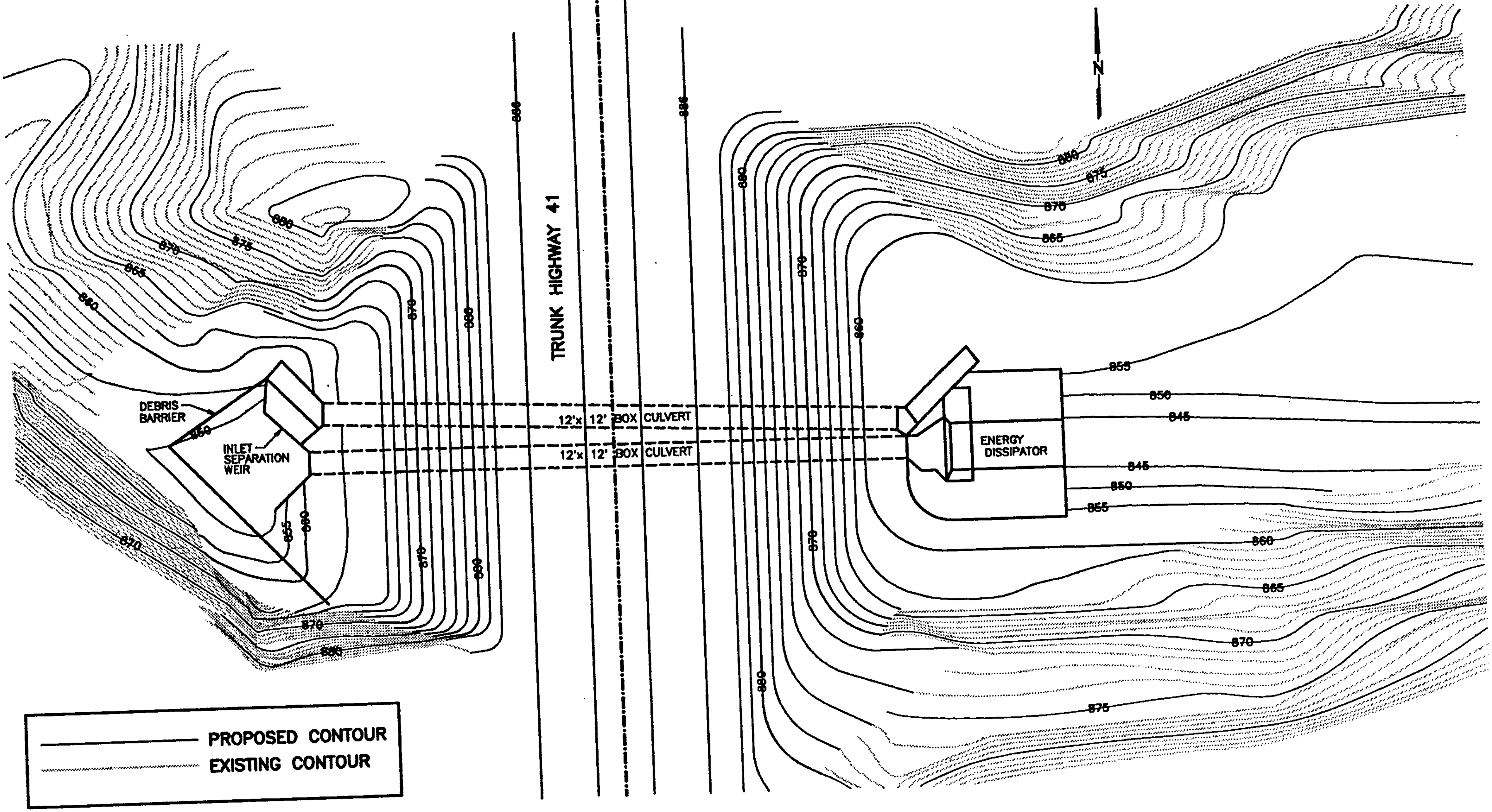
Engineers & Architects
St. Paul • Milwaukee

PLATE J-3

POND ELEVATION-DISCHARGE-STORAGE TABLES

T.H. 41	Elevation	Discharge (cfs)	Storage Volume (Acre-feet)
Proposed	850.0	0.0	0.02
12'x12'	851.0	48.9	0.06
culverts	852.0	136.1	0.16
	853.0	250.5	0.34
	856.0	707.3	2.20
	860.0	2186.0	10.6
	864.0	3623.0	40.9
	868.0	4914.0	81.0
	872.0	6162.0	151.0
	876.0	7192.0	261.0
	880.0	8067.0	428.0

T.H. 41	Elevation	Discharge (cfs)	Storage Volume (Acre-feet)
Existing	850.0	0.0	0.02
8' x 8'	851.0	25.2	0.06
culverts	852.0	129.2	0.16
	853.0	198.5	0.34
	856.0	459.7	2.20
	860.0	776.2	10.6
	864.0	981.9	40.9
	868.0	1149.7	81.0
	872.0	1295.4	151.0
	876.0	1426.2	261.0
	880.0	1545.8	428.0



SITE PLAN FOR PROPOSED CULVERT ALTERNATIVE

PLATE J–5

CITY OF CHASKA

TRUNK HIGHWAY 41 HYDRAULIC STRUCTURE

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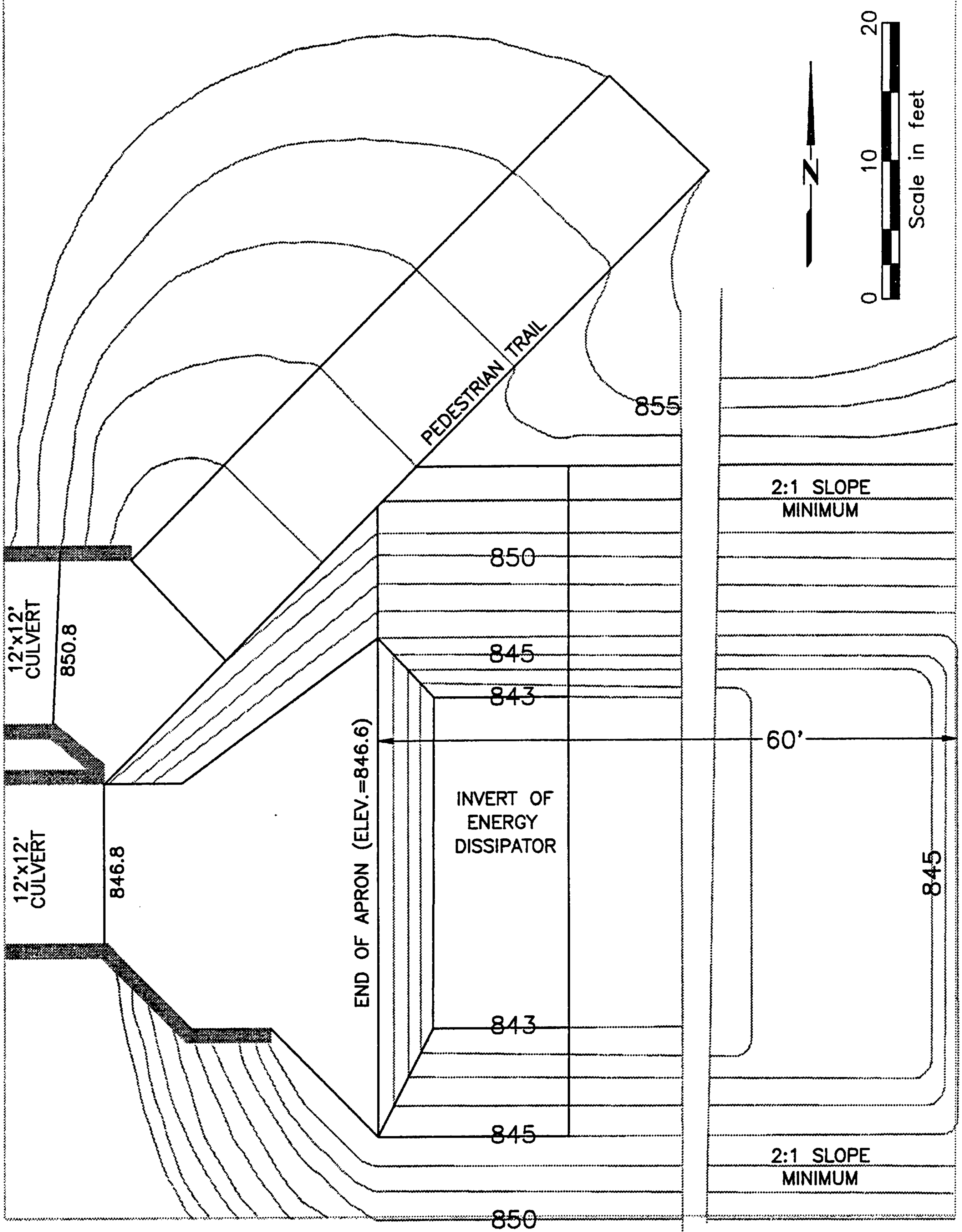
Bonestroo Rosene Anderlik & Associates



PLAN VIEW OF OUTLET

CITY OF CHASKA PLATE J-7

TRUNK HIGHWAY 41 HYDRAULIC PROJECT

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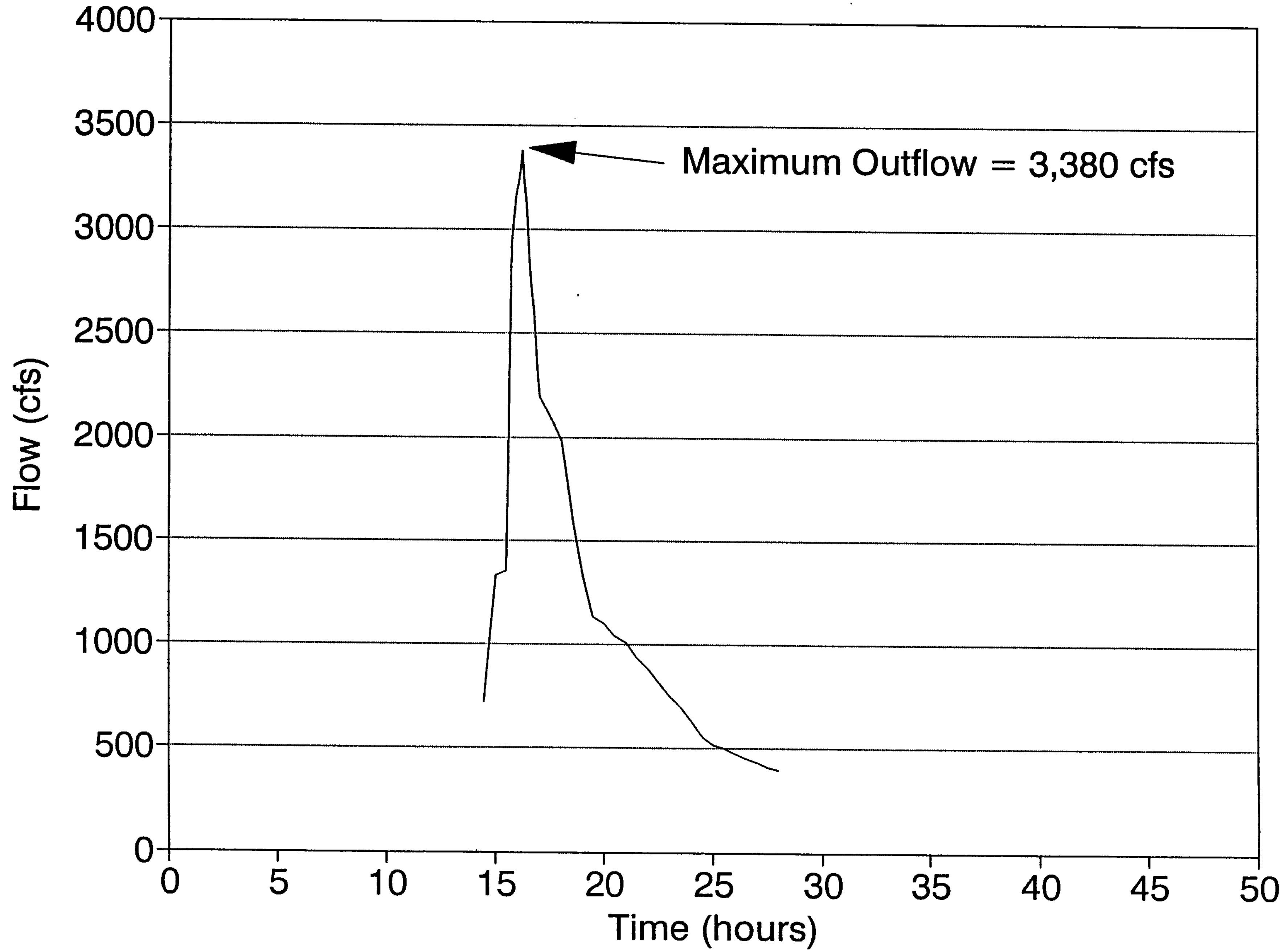

PLATE J-9 Outflow Hydrograph for T.H. 41